STATUS OF BOCACCIO OFF CALIFORNIA IN 2003

by

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EXECUTIVE SUMMARY

SPECIES/AREA: Bocaccio rockfish (*Sebastes paucispinis*) occurring in waters off the state of California. For management purposes, the stock may be considered to reside in U.S. waters south of Cape Mendocino. This stock assessment treats the resource in Southern and Central California as a combined unit.

YEAR	1951	1960	1965	1970	1975	1980	1985	1990	1995
TOT BIOMASS(mtons, age1+)	22924	15967	38660	43676	30039	28918	12634	8190	4896
SPAWN OUTPUT (10^9 eggs)	3630	2413	2690	8073	4864	3477	2074	1040	738
ABUND REL TO UNFISHED	27%	18%	20%	60%	36%	26%	15%	8%	6%
CATCH	2148	2702	1971	2451	5750	6037	2633	2451	777
EXPLOITATION RATE	9.4%	16.9%	5.1%	5.6%	19.1%	20.9%	20.8%	29.9%	15.9%

YEAR	1996	1997	1998	1999	2000	2001	2002	2003
TOT BIOMASS(mtons, age1+)	4560	4429	4260	4330	5166	5702	6506	7133
SPAWN OUTPUT (10^9 eggs)	721	711	704	734	764	790	843	984
ABUND REL TO UNFISHED	5%	5%	5%	5%	6%	6%	6%	7%
CATCH	573	480	209	197	187*	171*	201	
EXPLOITATION RATE	12.6%	10.8%	4.9%	4.5%	3.6%	3.0%	3.1%	

VALUES IN THIS TABLE ARE FROM THE STATc MODEL

* catch is partially based on unobserved, assumed discard rate

CATCHES: Catches declined from the 1970s to 1990s, leveling off since 1998, reflecting both a long-term decline in abundance and progressive restrictions on harvest of bocaccio. Values of catches in recent years are imprecise, for example because of undocumented discarding. Discard rate in unobserved 2000 and 2001 commercial fisheries is assumed to be half of that observed in 2002.

DATA AND ASSESSMENT: The last assessment was conducted in 2002. Like the previous assessment, this assessment uses a length-based stock synthesis model, extending back to 1951. Data included catches from five fisheries segments reflecting three statewide commercial gears (trawl, setnet, hook&line), and separate southern California and northern California recreational fisheries, length compositions from six sources (all five fisheries segments, and the Triennial Survey), and six indexes of abundance (trawl logbook CPUE, three recreational CPUEs, Triennial Survey abundance, and CalCOFI larval index of spawning output). Three indexes of recruitment were developed (Central California Juvenile Rockfish Survey, Southern California Power Plant Impingement Index, and recreational CPUE from fishing piers), but were not used. The assumed natural mortality rate was reduced to 0.15 from 0.20 in the 1999 and 2002 assessments.

WHY IS THIS 2003 ASSESSMENT DIFFERENT FROM THE 2002 ASSESSMENT? The 2002 assessment model was dominated by the 2001 Triennial Survey, which showed a very low bocaccio abundance and no sign of the 1999 year class. The result was that both abundance and productivity appeared to be very low; projected rebuilding times were over 100 years, and allowable catches for rebuilding were near zero. In this 2003 assessment, additional CalCOFI larval abundance information, and both length composition and CPUE information from the recreational fisheries indicate a sharp increase in abundance and a much stronger 1999 year class. The 2003 assessment more closely resembles the 1999 assessment, and median rebuilding times are in the 20-25 year range with currently allowable rebuilding catches in the hundreds of tons.

UNRESOLVED PROBLEMS AND MAJOR UNCERTAINTIES: The contrasting information from the low 2001 Triennial Survey and the high recent recreational CPUE has not been reconciled. The STAR Panel adopted two "equally likely" but separate models, one omitting the Triennial Survey data (STARb1), and the other omitting the recreational CPUE data (STARb2). The STAT Team prefers a single intermediate model (STATc) including all of the data despite their inconsistencies, with the STAR models serving as sensitivity analyses. The PFMC's SSC agreed that the STATc model is a reasonable intermediate approach, and should be considered alongside the two STAR models.

	2003			2004		REBUILDING SUMMARY				
MODEL	SPAWNOUT	REL	TOT(MT)	ABC(MT)	C(40-10)	TARGET	OY(70%)	Tmed(70%)	Tmax	Tmin
STARb1	1136	8.5%	8913	660	0	5365	625	20	25	12
STARb2	733	5.6%	5455	400	0	5226	250	25	30	17
STATc	984	7.4%	7133	501	0	5355	306	23	28	16

The low level of abundance (15 to 27% of estimated unfished abundance) in 1951-1965 raises questions regarding the validity of the estimate of unfished abundance, and the appropriateness of the rebuilding target. In the 53 years covered by this assessment, stock abundance was above the current rebuilding target in only 8 years, from 1967 to 1974. However, catch levels were already near the estimated MSY (see below) in the early 1950s, suggesting that initial abundance in the model should not be expected to be near an unfished level.

REFERENCE POINTS: Values are reported for the intermediate STATc model. Population reproductive potential is measured as spawning output (units of billion eggs). Unfished abundance cannot be estimated reliably from historical stock and recruitment due to lack of curvature in the relationship. An imprecise estimate of unfished spawning output was obtained by multiplying the average age-1 recruitment (1951 to 1986) by unfished SPR, giving 13387 billion eggs, which is similar among all three models.

Based on the 50%SPR exploitation rate of 0.0638 (F=0.103 at full selectivity) used as a proxy Fmsy rate by the PFMC, the 2003 exploitation rate of 0.0309 is well below the maximum fishing mortality threshold. At Fmsy, the STATc model gives a 2004 catch of 501MT. Proxy Bmsy (40% of Bunfished) corresponds to an equilibrium total biomass of 39,255MT, and if this is fished at proxy Fmsy, the MSY is estimated to be 2504MT.

STOCK BIOMASS: From the STATc model, the estimated spawning output in 2003 is 984 billion eggs, or 7.4% of the estimated unfished level. The estimated 2003 total biomass (age 1+) is 7133 MT.

RECRUITMENT: The last significant recruitment appeared as age 1 fish in 2000 (the 1999 year class). The strength of this cohort was difficult to determine until it appeared clearly in 2002 fishery catches. The 1999 year class is now estimated to be much larger than it was in the 2002 assessment.

MANAGEMENT PERFORMANCE: The stock was heavily overfished up to the late 1990s, but exploitation rates have favored rebuilding since 1998. Recent catches exceeded the 100 MT rebuilding target set for 2000-2002, but appear not to have compromised the stock's rebuilding capacity (contrary to the findings of the 2002 assessment).

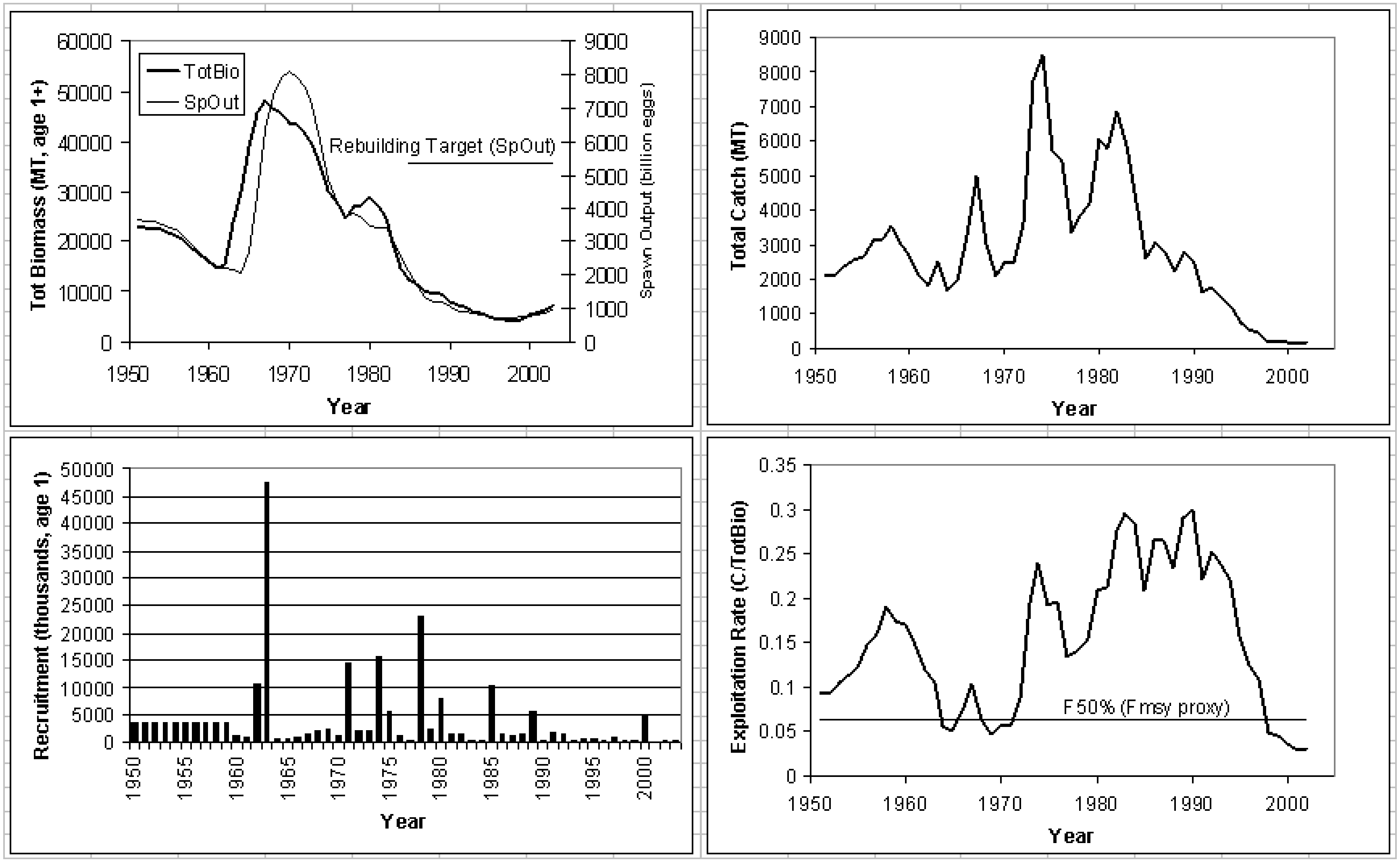
FORECASTS: Spawning abundance will continue to increase for several years as the 1999 year class matures. Various harvest levels are possible, depending on choice of rebuilding policy. The STATc model provides approximate values of future fishing effort necessary to achieve a constant fishing mortality rate. The 2002 fishery effort is used as a reference level.

C2004(MT)	200	300	400	500
F	0.035	0.055	0.0774	0.103*
Effort rel to 2002				
2004	84%	131%	182%	240%
2005	80%	125%	174%	229%
2006	76%	118%	164%	216%
2007	72%	112%	156%	206%
2008	69%	108%	152%	200%
2009	68%	107%	150%	198%
2010	68%	107%	150%	198%

* Fmsy

RECOMMENDATIONS: A revised rebuilding analysis will accompany this assessment document. Future assessments will continue to improve the estimate of the important 1999 year class, and will also help resolve the conflict between the Triennial Survey and recreational fishery information.

REFERENCES: STAR Panel Report, Rebuilding Analysis



Long-term patterns of bocaccio abundance, catch, recruitment and exploitation rate.

Introduction

A bocaccio assessment was completed in 2002, and indicated a low abundance with poor prospects for rebuilding. Due to the harvests taken in 2000 through 2002, rebuilding within the time frame established by the National Standard Guidelines could not be accomplished. Management imposed major restrictions on groundfish fishing off California in order to keep bocaccio catches as low as possible while providing limited fishing opportunities for other groundfish species. Several aspects of the 2002 assessment needed further analysis, and a re-assessment was requested for 2003.

The 2003 re-assessment included many new analyses, and was reviewed by a STAR Panel in April, 2003. The STAR Panel provided a number of corrections and improvements to the assessments, which are gratefully acknowledged. However, with respect to the overall assessment, a dispute exists between the STAR Panel and STAT Team: The STAT Team contends that the STAR Panel functioned as an alternative STAT Team (i.e., assessment author) rather than a review body. The specifications of the two bocaccio models (STARb1 and STARb2) developed by the STAR Panel were developed independently and without any significant input from the STAT Team. The STAT Team considers the two "equally likely" STAR models to be inappropriate as a basis for bocaccio management, and presents a third intermediate model (STATc) as a proposed basis for management. The STATc model was endorsed by the SSC as being a reasonable intermediate model. All three models are fully described in this document, and technical details are presented in later sections.

New Aspects of this Assessment

– The assumed natural mortality rate was revised (from 0.2 in 1999 and 2002) to a value of 0.15.

– Estimates of bocaccio catches by the foreign fisheries (1966-1976) are included in the catch history. About 12,000 mtons were caught during this period.

– Delta-lognormal and delta-gamma GLMs are used extensively, and precision is estimated by full jacknife of individual observations.

– The CalCOFI Index includes recent data from 2001, 2002 and February 2003, and includes all stations from Mexico to San Francisco. The stock synthesis model now fits the spawning biomass index directly, rather than by means of an artificial selectivity curve. The historical geographic distribution of the resource also was determined from these data.

– Recreational CPUE from the RecFIN database is based on a new method that identifies relevant fishing trips by species composition. Recreational CPUE was adjusted for the effect of discards, avoidance, and for the change in bag limits.

– Recreational CPUE from the CDF&G northern California partyboat monitoring was analyzed by a GLM including site and depth effects. A depth distribution of bocaccio recreational availability was determined from this source.

– A new (but imprecise) index of recruitment strength was developed from bocaccio catch rates at fishing piers. The geographic pattern of bocaccio recruitment was identified from these data.

History of Management

Only the most recent regulations for bocaccio are presented here. Earlier regulations appear in previous stock assessments. Regulations were complicated by various emergency actions. California-regulated fisheries (e.g., pink shrimp) are not included.

January 2001 (Emergency closure on October 29, 2001)
Recreational
- Bag limit: 10 rockfish, only 2 bocaccio, 10" minimum size
- North of Cape Mendocino: open year round
- Cape Mendocino - Pt. Conception: closed March-June except inside 20 fathoms - open May-June
- Pt. Conception south: Closed January-February except inside 20 fathoms (open all year)

Commercial:
- Limited Entry (fixed and trawl):
- Southern Area: 300 lbs/month Jan-April and Nov-Dec, otherwise 500 lbs/month
- Open Access: 200 lbs/month year round

January 2002
Recreational — Note:Emergency closure was enacted outside 20 fm on July 1, 2002, with no recreational retention of bocaccio
- Bag limit: 10 rockfish, no more than 2 bocaccio if not prohibited
  - Inside 20 fathoms, central area: recreational fishing allowed May-June and Sep-Oct, but bocaccio may not be retained
  - Outside 20 fathoms, central area: open January-February and July-August
- All southern waters: open March - October

Commercial — Note: Under emergency action, bocaccio cannot be retained commercially after July 1.
- Limited Entry Trawl: Jan-April 600 lbs/2 months, May-Oct 1,000 lbs/2 months, Nov-Dec 600 lbs/2 months
- Limited Entry Fixed Gear:
  - North of Cape Mendocino: 200 lbs/month
  - Cape Mendocino - Pt Arguello: 200 lbs/month Jan-Feb and July-Aug, closed otherwise
  - South of Pt. Arguello: 200 lbs/month March-Oct, closed otherwise
- Open Access:
  - North of Cape Mendocino: 200 lbs/month
  - Cape Mendocino - Pt Arguello: 200 lbs/month Jan-Feb and July-Aug, closed otherwise
  - South of Pt. Arguello: 200 lbs/month March-Oct, closed otherwise

May 2002
- Limited Entry and Open Access fixed gear:
  - no retention between Cape Mendocino and Pt. Arguello, 200 lbs/month south of Pt. Arguello

September 2002
- Limited Entry and Open Access Trawl:
  - no retention south of Cape Mendocino

January 2003
Recreational
- No bocaccio may be retained

Commercial
- Limited Entry Trawl and Fixed gear: no bocaccio may be retained south of 40-10. Northern limit is 2 fish.
- Open Access Gear: no bocaccio may be retained

Stock Distribution and Life History

Stock Distribution: The bocaccio stock addressed by this assessment ranges from Northern Baja California, Mexico, to the California-Oregon border, but with a functional northern limit of Bodega Bay, just north of San Francisco. The historical distribution of spawning abundance over this range is 4.6 percent in Mexican waters, 46 percent in Southern California waters, and 50 percent in Central/Northern California waters from Pt. Conception to Bodega Bay (see CalCOFI Index of Spawning Output, below). This assessment treats the stock as a single unit, in keeping with the recommendations of the 2002 STAR Panel. A new analysis of bocaccio recruitment along the California coast (see Recruitment Index Based on MRFSS Pier Sampling, below) indicates that bocaccio recruitment typically occurs from Santa Barbara to Santa Cruz, and is rare south of Ventura, with no evidence of separate southern California recruitment events. Nonetheless, the stock is sufficiently widespread that status may differ between Southern California and Central California. Proper representation of such internal stock structure is technically impossible at present and this assessment does not attempt to distinguish between the two regions except in estimating separate selectivity curves for the respective recreational fisheries.

Natural Mortality Rate: In 1996, Ralston and Ianelli reviewed the information relating to the natural mortality rate of bocaccio, and settled on M=0.15. In 1999, MacCall encountered computational instability in the stock synthesis model (resulting in "crashes") when using M=0.15, but was able to complete model development and exploration using M=0.2, which was adopted as the base model. Richard Methot (NMFS, Pers. Comm.) subsequently improved the computational methods in the synthesis model, eliminating the computational problem. In the 2002 assessment, MacCall examined both M=0.15 and M=0.25, but retained M=0.2 as the base model because it was consistent with the previous assessment and rebuilding analysis. During discussions following the 2002 STAR Panel, it was generally agreed that M=0.2 was probably too high, and lower values of natural mortality rate should be considered.

As reported by Ralston and Ianelli (1996), the maximum known age of bocaccio is 45 years (this maximum age has been confirmed in an independent study of bocaccio off Oregon, Kevin Piner, Pers. Comm.). Although age determinations of bocaccio are known to be imprecise, this value will be assumed to be valid. The method of Hoenig (1983) gives an estimated total mortality rate of 0.092 for this maximum age, but the Hoenig estimate is a geometric mean (this does not seem to be widely recognized). The standard error of Hoenig's estimator is not given, but visual inspection of his data suggest a value of about s=0.4 on a log scale. The geometric mean bias correction, $\exp(s^2/2)$ is about 1.08, giving a bias-corrected estimate of 0.1 for the total mortality rate.

The STAT Team prefers use of M=0.1, but the STAR Panel decided that the appropriate value should be M=0.15 (see STAR Report). Consequently, a value of M=0.15 is used in the base model.

Length at Maturity (Spawning Ogive): Previous assessments used length at 50% maturity of 47.6 cm FL, based on Wyllie Echeverria (1987). This value is from samples taken 20 years ago, when the bocaccio population size was much higher than it is now. Recent maturity observations (n=18,205 during 1993-2001) are available from port sampling (Don Pearson, Pers. Comm.). When presence of "eyed larvae" is used as the criterion for maturity, the results agree closely with the Wyllie Echeverria value, which is retained in this assessment. It is interesting to note that when the criterion of "eggs present" is used, the 1993-2001 maturity ogive appears to shift toward younger fish. This merits further study, and cannot be reconciled here.

Length at Age: Female bocaccio grow to a larger size than males. Because this assessment is based on length compositions, growth curves for males and females are fit within the model rather than specified externally. This is possible because of the strong modal structure of length compositions associated with rare strong year classes. However there does appear to be long-term variability in expected length at age, leading to imprecise fits at larger sizes and low estimated effective sample sizes (see Effective Sample Size, below).

Fishery Catches and Fishery-Based Abundance Indexes

Catches were divided into five fishery segments. Commercial fisheries were aggregated statewide, and were divided into three gear groups, trawl, hook and line, and setnet (gillnet). Recreational fisheries were aggregated for all modes of fishing, but were divided into northern and southern California regions.

Commercial Fishery Data

Catches: The history of commercial catches (Table 1a) was estimated following the procedure developed by Ralston and Ianelli (1996) and also used by MacCall (1999). The MacCall (2002) assessment considered separate northern and southern California segments of the commercial fisheries, but given subsequent treatment as a single stock, that approach has been abandoned in order to simplify the model. California commercial catches since 1978 were obtained from the CALCOM database. In cases of unknown species, samples were allocated to bocaccio according to typical patterns in corresponding market categories (Don Pearson, SWFSC/SCL, Pers. Comm.). Rogers (2003) has estimated catches by the foreign fishing fleets during 1963-73, and these historical catches have now been included.

Discarding was monitored by a NMFS observer program during 2002, giving a ratio of 5.45 tons of fish caught (retained + discarded) per ton of fish retained (Owen Hamel, NWFSC, Pers. Comm.). The reported value of commercial bocaccio landings in 2003 was multiplied by this ratio to obtain the estimated bocaccio catch. Fishing before 2000 is assumed to have been unrestricted, and no correction is made for discarding. Fishing in 2000 and 2001 was restricted, but less so than in 2002. As an approximation, the discarding correction in 2000 and 2001 was assumed to be half of the 2002 value, i.e., 2.7 tons of fish caught (retained + discarded) per ton of fish retained (Table 1b).

Length Composition: Length composition of commercial landings were obtained from the CALCOM database, and cover years 1978-2002. Figure 1 shows the length compositions for female bocaccio. Sample size information is given in Table 2. In 2002, the observer program provided a small sample of length compositions of retained (n=53) vs. discarded (n=142) bocaccio from trawl fisheries off California (Jonathan Cusick, Pers. Comm.). In most observed trips, bocaccio were either all retained or all discarded. In the two trip with partial discard, there was a clear tendency to retain the larger fish. Although this indicates that size-dependent discard has occurred to some extent, data are not yet sufficient to develop reliable size-dependent discard rates for use in the assessment model.

Trawl Catch per Unit Effort: Ralston (1999) developed a CPUE index of bocaccio abundance based on California trawl logbooks (Figure 2). Because the logbooks do not identify most individual species such as bocaccio, Ralston applied species compositions from local port sampling to the overall catch rates of rockfish from the trawl logbooks. This assessment uses Ralston's "area-weighted" index of bocaccio CPUE, and the associated standard errors (average CV is 29%).

Recreational Fishery Data

Catches: Catches, including estimated discards (RecFIN type "B1" – discarded dead) since 1980 were obtained from the RecFIN website. Recreational catches prior to 1980 were estimated according to the methods described in Ianelli and Ralston (1996) and MacCall (2002). Pre-1980 northern and southern California catches were estimated from published estimates of total rockfish caught in those areas. The history of estimated recreational catches is shown in Tables 1a and 1b.

Length compositions: Length compositions of bocaccio caught by recreational fisheries were obtained from three sources. Bocaccio lengths from both private boat and partyboat fisheries have been collected by MRFSS intercept samplers since 1980 (except for 1990-92) in both Northern (n=6,438) and Southern California (n=14,345). These data are available from the RecFIN database. The CDF&G conducted on-board partyboat sampling program in Northern California from 1983-98 (n=11,753, Deb Wilson-Vandenberg, CDF&G, Pers. Comm.). This assessment also incorporates a newly-discovered large data set of bocaccio lengths (n=78,371) from on-board sampling of the Southern California partyboat fishery during the period 1975-78. Sample size information is given in Table 2.

Visual examination of length compositions from the private boat and partyboat catches indicated that the length compositions are similar, allowing samples from both partyboat and private boat fishing modes to be combined. Recreational fisheries in Southern California and Northern California could exhibit different selectivity curves and were treated as independent fisheries. Length compositions from recreational fisheries include many young, fast-growing fish, and combining raw lengths from all months causes "smearing" of the length modes, and also can cause difficulty in estimating likelihoods because the synthesis model assumes all fish to be captured at mid-year. In order to reduce the magnitude of this fitting problem, fish lengths were converted to equivalent lengths on July 1 of the year of capture, using the von Bertalanffy growth equation (Quinn and DeRiso 1999, equation 4.10):

$$L(t+\Delta t) = L(t) + (L_\infty - L(t))*(1-\exp(-k\,\Delta t))$$

where asymptotic length (L_∞) and growth rate (k) are the mean of the male and female values estimated in the 2002 assessment (708mm FL, 0.19/yr). Sex-specific length corrections cannot be used because sex is unknown for fish sampled from the recreational fisheries. Depending on the available information on date of capture, the incremental time, Δt in years, is calculated as

$\Delta t =$ (calendar date - 180)/360 where all months are assumed to be 30 days in length, or

$\Delta t =$ (wave - 3.5)/6 in the case of RecFIN samples, where date of capture is known only by bimonthly sampling wave.

The resulting recreational fishery length compositions are shown in Figure 3. Strong yearclasses appear as distinct modes, progressing in size as they grow through their first several years of age; the 1977, 1984 and 1999 year classes are especially notable.

<u>Catch per Unit Effort:</u> Recreational catch and effort data were taken from two sources, the RecFIN database (Wade VanBuskirk, Pers. Comm.) and the Northern California partyboat monitoring conducted by CDF&G (Deb Wilson-Vandenberg, Pers. Comm.). Sample sizes are given in Table 2. These two sources contain different kind of information and were treated differently. Only the partyboat catch and effort data from the RecFIN database were used in this analysis. Bocaccio catch rates from private boats appeared to be less consistent than those from partyboats.

RecFIN CPUE: The RecFIN intercept data (which include MRFSS data) reflect sampling and interviews conducted at the end of a fishing trip, and do not include information on specific fishing locations. A new multispecies discriminant function analysis was developed to identify which fishing trips are appropriate to include in calculation of a CPUE index of abundance. The concept behind the new method is that the species mix in the catch of a fisherman or a fishing trip is indicative of the habitat where fishing occurred, allowing discrimination between those trips where the target species (bocaccio in this case) could have been caught and trips where bocaccio were unlikely to have been caught. The latter trips are not informative, and should be excluded from the CPUE analysis.

The first step in the analysis consists of identifying the general list of species commonly caught on fishing trips in the region under consideration. Those species occurring in at least one percent of the records are included in the analysis (a typical data set included at least 50,000 records spanning the period 1980-2002). Records for each fishing trip, ideally at the aggregate boat level rather than at the individual fisherman level, are converted to a vector of presences (1) and absences (0) of those species. Note that quantitative catch could be used, but presence and absence should be less influenced by trends in species abundance. For each trip record (j), the probability of the target species (bocaccio) being present was fit by maximum likelihood using a logit function based on an indicator function (I) consisting of the sum of estimated species-specific coefficients, C_i:

$$I_j = \sum_i s_i C_{ij}$$

$$\text{where } s_i = \begin{cases} 1 \text{ if species i is present} \\ 0 \text{ if species i is absent} \end{cases}$$

and i = 1 to n non-bocaccio species.

Estimated probability (p_j) that bocaccio is present is given by the logit function

$$p_j = \exp(I_j)/(1 + \exp(I_j))$$

and the log-likelihood function is

$$\ln \mathcal{L} = \sum_j \ln(L_j)$$

$$\text{where } Lj = \begin{cases} p_j \text{ if } s_T = 1 \text{ (i.e. bocaccio are present)} \\ (1-p_j) \text{ if } s_T = 0 \text{ (bocaccio are absent)} \end{cases}$$

and s_T indicates presence (1) or absence (0) of the target species T in record j.

The coefficients are estimated by maximizing the log-likelihood (this was done in an Excel spreadsheet, using the "solver" tool). The species-specific coefficients (Figures 4, 5) include large positive values for species that consistently co-occur with bocaccio (e.g., chilipepper and bank rockfish), and large negative values for species that occur in habitats where bocaccio are unlikely to be encountered (e.g., oceanic species such as albacore, and nearshore species such as barracuda). Comparison of coefficients estimated from years1980-1989 with those estimated from 1993-2001 indicate that estimated coefficients are stable over time; this analysis uses coefficients estimated from all years combined.

In the second step, each trip record is assigned an estimated probability that bocaccio could have been encountered. The trip records are sorted by descending probability, and a threshold probability is chosen for exclusion of trips from the CPUE calculation. Average bocaccio catch per angler declines with decreasing estimated probability of encounter (Figure 6). Selection of a threshold probability requires balancing the sample size (favoring a low threshold probability) against the suitability of fishing trips for calculation of CPUE (favoring high threshold probabilities). In the present case, a threshold probability was chosen corresponding to an average catch rate of one bocaccio per record (where the slope of cumulative fish is equal to the slope of cumulative records, see Figure 6).

In the third step, records were corrected for discarded fish. The RecFIN database was queried to obtain numbers of fish retained (RecFIN type "A"), numbers discarded and presumed dead (RecFIN type "B1"), and numbers discarded and presumed alive (RecFIN type "B2"). For each record, the retained catch (numbers of fish) per angler was divided by the retention rate (A/(A+B1+B2)) for that year and wave to obtain a total catch per angler estimate. Discarded fish are assumed to have the same characteristics as retained fish. It is likely that discarded fish tended to be smaller than retained fish, but there are no data by which to test this "high-grading" hypothesis, or to correct for its potential effects.

The fourth step is to apply a delta-GLM to the retention-corrected records. Data from 1980 through the third wave of 2002 were included. The GLM included year (22) and wave (6) effects (region effects could have been used to produce a single coastwide analysis, but possible regional differences in selectivity at age argues for separate abundance indexes, see selectivity curves estimated below). Delta-gamma GLMs produced lower average CVs and were used in this analysis.

The fifth step is to correct the CPUE index for bag limits and for intentional avoidance of bocaccio. Beginning in 2000, partyboats attempted to avoid fishing in areas where bocaccio were present, and often would change locations if bocaccio were encountered. In 2002, a two-fish bag limit was enacted, and although not all fishermen observed the limit strictly (the 2002 records include numerous bags exceeding two bocaccio per angler), the two-fish bag limit presumably caused a decrease in CPUE relative to the previous unrestricted condition.

Bag sizes (number of bocaccio) follows an exponential distribution (Figure 7). For each year, the average bag size was plotted against the ratio of bags 2 or larger to bags of size 1. This ratio is correct independently of whether the two-fish bag limit is strictly observed. For years preceding 2000, the data are described by linear relationships (Figure 8), and were fit by linear regression. Presumably due to abandoning fishing locations where bocaccio were encountered, the average bocaccio bag sizes in 2000 fall slightly below the linear relationship. In 2002, under the impact of a two-fish limit, the average bocaccio bag sizes fall far below the historical pattern. For each region separately, a correction factor consisting of the ratio of average historical bag size predicted by the linear regression to the observed average bag size was applied to the respective year effect from the GLM to produce a value that would be expected to have occurred in the absence of avoidance and bag limits. Final CPUE abundance indexes are shown in Figures 9 and 10.

CDF&G Partyboat CPUE: The California Department of Fish and Game conducted on-board monitoring of partyboat catches in Northern California from 1988 to 1998. Presence of location and depth information associated with catch and effort at individual fishing sites (Deb Wilson-

Vandenberg, Pers. Comm.) allowed a more direct identification of appropriate records for use in a CPUE calculation. The analysis used only those fishing sites with at least seven occupations and at least five positive occurrences of bocaccio catch in the data set. Initial exploration allowed collapse of monthly effects into a seasonal winter (January, February and March) and nonwinter effect; also the few records from depths greater than 80 fm were combined to form an 80+ fm depth effect. The final delta-lognormal GLM included year (12), season (2), site (100) and depth(8) effects. The estimated depth effects (Figure 11) show a very clear tendency for bocaccio catch rates to increase to a maximum at about 60 fm. The site effects (Figure 12) indicate a number of coastal areas where local catch rates of bocaccio tend to be high. The CPUE index is shown in Figure 13.

Fishery-Independent Data

Triennial Survey Index: The Alaska Fisheries Science Center has conducted bottom trawl surveys every three years off the west coast since 1977, with the most recent survey in 2001. Sample size information is given in Table 2. The Monterey INPFC area was sampled on every survey, but the Conception area was not sampled on the 1980, 1983 and 1986 surveys. The 1977 survey did not sample the 55-91m depth range, but Ralston et al (1996) showed that very few bocaccio tend to be encountered in this range, so no attempt is made in this assessment to adjust the 1977 index for this small difference. Recent analysis of historical Triennial Survey trawl performance identified a problem with the extent of bottom contact by the net during the early years of the survey (Zimmerman et al. 2001). The questionable trawl samples have been deleted from the Triennial Survey data used in this analysis (pers. comm., Mark Wilkins, AFSC).

I used a simple log-transformed GLM to obtain bocaccio abundance indexes from the triennial survey stratum means; the GLM treatment provided a means of estimating the index despite the Conception region not having been surveyed in some years. Factors were survey year, area (Conception vs. Monterey), and depth stratum (nearshore, 55-183m, vs. and offshore, 184-366m). Values from the Eureka INPFC area were not included, as bocaccio were too rare in the catches to be informative. The coefficient of variation of the GLM index was assumed to be the same as the directly-calculated CV for the combined strata. The resulting index was imprecise, with CVs ranging from 30% to 80% (Figure 14).

The Triennial Survey also provides length compositions of the sampled fish (Figure 15). Length compositions from before 1989 were not used in this assessment, as the STAR Panel questioned whether the earlier samples were comparable to those collected more recently.

CalCOFI Index of Spawning Output: Abundances of larval bocaccio sampled by CalCOFI surveys in most of the years from 1951 to 2003 (Moser et al. 2000) provide an index of bocaccio spawning output off Mexico and California. Bocaccio larvae have been quantified for all surveys since 1972, but for years before 1972, samples with reliable bocaccio identifications are only available for CalCOFI Lines 77 (Port San Luis) to 93 (San Diego). Sample sizes are summarized in Table 2.

Initially, the full data were analyzed by a pivot table to identify months when bocaccio larvae were consistently present. This period was November through May; the remaining months were deleted from consideration. Year values were adjusted to year+1 for November and December samples in order to associate those samples with the relevant spawning season. A delta-lognormal GLM with year, month and station effects (a station required at least one positive observation to be included) was used to describe the overall monthly and station distributions. A separate GLM with at least three positive stations was used as the basis for jackknife estimates of precision; many stations off Mexico (lines 100 to 113) had less than three positive observations.

Spawning Seasonality: The monthly distribution of larval abundance has a clear peak in January, and November and May values are very low (Figure 16). Bocaccio are known to spawn in other months, but the pattern is not consistent from year to year, and restriction to the months considered here decreases the imprecision that could arise from multiple spawnings.

Geographic Distribution of the Stock: CalCOFI lines are perpendicular to the coastline and are equally spaced at about 40-mile intervals. The geographic distribution of spawning bocaccio was summarized by line-specific relative population sizes. Areas represented by individual stations were calculated by the midpoints between stations along the CalCOFI line, and assuming constant width between lines. The shoreline was used as the nearshore boundary, and the outermost station was assumed to lie at the midpoint between its inner and outer boundaries. Abundances at stations were estimated by multiplying by the area represented by the larval density at that station. This procedure is equivalent to a two-dimensional Sette-Ahlstrom abundance estimate.

The long-term geographic distribution of bocaccio spawning output is shown in Figure 17. Historically, 50 percent of the spawning population has resided north of Pt. Conception, 46 percent in southern California waters, and 4.6 percent in Mexican waters. Precision of line-specific abundances was calculated as the average CV of the individual stations on that line. Lines 77 to 93 have a much lower CV due to the larger sample sizes and full 51 years of temporal coverage.

CalCOFI Index Selectivity: The most recent version of stock synthesis includes the ability to fit a spawning biomass index directly (Rick Methot, Pers. Comm.). This is an improvement over the previous assessment, which required construction of an artificial selectivity curve to approximate the contribution of age groups to the spawning biomass.

Spawning Output Index: The spawning output index used in the assessment is based on the estimated year effects (Figure 18) from a delta-lognormal GLM (43 years, 7 months, 70 stations; 8247 observations) with at least three positive observations in each effect (allowing jackknife estimates of precision). Year effects include most of the years from 1951 to 2003. The most recent data, collected at sea in February 2003, include Central California coverage and were processed in record time by the NMFS La Jolla Laboratory (Richard Charter, Pers. Comm.).

Recruitment Indexes

Two recruitment indexes were used in the 2002 assessment: the Central California midwater trawl surveys of juvenile rockfish, and an index based on impingement rates at southern California electrical generating stations (power plants). This assessment adds a third recruitment index based on catches of bocaccio from piers. However, the recruitment indexes are not used in the assessment, per STAR Panel recommendation. Descriptions of the recruitment indexes are retained in the assessment because they provide useful auxiliary information regarding bocaccio life history and population structure.

Central California Midwater Trawl Juvenile Survey: A midwater trawl survey of pelagic juvenile rockfish abundances has been conducted at 33 standard stations between Pt. Sur and Pt. Reyes since 1983. Except for four years, sufficient number of bocaccio juveniles were sampled to allow the data to be analyzed by a delta-lognormal GLM based on year, station and temporal effects (average CV of year effect was 0.47 for delta-lognormal, and 0.54 for delta-gamma). The temporal effect reflects the brief period of pelagic juvenile availability to the sampling gear, and consists of five ten-day intervals in the range of 125 to 175 days after January 1. The last two of these intervals (i.e., early- to mid-June) show a progressive reduction in the number of juvenile bocaccio sampled (Figure 19). The year effects show a general decline in recruitment strengths since the 1980s, with a slight increase since the late 1990s (Figure 20). The average coefficient of variation of the year effects is 0.47.

Southern California Power Plant Impingement Index: New data were not available. Data used in the 2002 assessment were re-analyzed using the more thorough jacknife capability now available, but using the same assumptions as in that assessment. A delta-lognormal GLM was used because of the need to weight observations according to source (data from three separately monitored intakes at San Onofre were given a combined weight equivalent to a single site). The time series (Figure 21) shows a general tendency for recruitment to have declined over time. The index is valuable for its 30-year coverage, but even the more precisely estimated years have CVs of about 1.

Recruitment Index Based on MRFSS Pier Sampling: Numerous reports of catches of juvenile bocaccio from fishing piers suggest that bocaccio CPUE from fishing piers could provide an index of recruitment strength. Observed hours fished for all species and catches of bocaccio from man-made structures (i.e. fishing piers) were retrieved from the RecFIN Database for the years 1980 to 2002 (with 1990-92 missing), six bimonthly sampling periods ("waves"), and by coastal county from San Diego County to San Francisco County. Based on these data, San Luis Obispo County is clearly the center of historical bocaccio recruitment, with Santa Barbara to Santa Cruz Counties being the typical geographic range of presumptive recruitment events (Figure 22). In this data set, juveniles were rarely observed at piers in Ventura and Los Angeles Counties, and none at all have been reported from piers in either Orange or San Diego Counties. Juvenile bocaccio are most commonly observed at fishing piers from May to October (waves 3, 4 and 5). Accordingly, the data used to develop the Pier CPUE Recruitment Index were restricted to the four counties from

Santa Barbara to Santa Cruz, and waves 3, 4 and 5. A delta-gamma GLM produced a slightly lower CV of year effects (average CV = 1.03) than did a delta-lognormal GLM (average CV = 1.06). Three years had only a single positive observation and did not allow use of the jackknife. The final index was based on year effects from a delta-gamma GLM including the single observation cases (Figure 23). The index is very imprecise, and at current sampling frequencies, monitoring of catch rate from piers is of doubtful value as an indicator of recruitment.

Assessment Model

The assessment was conducted using the Stock Synthesis length-based maximum likelihood model (Methot 1990). Natural mortality rate is set at M=0.15 except in sensitivity analyses.

STAR and STAT Models: The STAR Panel was concerned about the disagreement between the Triennial Survey data, which showed no increase in abundance, and the rec recreational fishery CPUE, which showed a strong increase in abundance. The Panel adopted two separate and "equally likely" models, both of which exclude the three recruitment indexes (STAR Panel Report). Model STARb1 excludes the Triennial Survey data and uses constant recruitment from 1951-1959. Model STARb2 excludes the recreational CPUE data and uses constant recruitment from 1951-1969. Following the STAR Panel review, the STAT Team developed a third model (STATc) that includes both Triennial Survey and recreational CPUE data, uses constant recruitment from 1951-1959, and also excludes the three recruitment indexes. The two STAR models do not include the goodness of fit to the stock-recruitment relationship (SRR), but the STATc model includes a weak (emphasis = 0.1) SRR component for the purpose of stabilizing estimates of recruitments for years with very little informational basis for estimation.

Tuning: The estimates of precision which are important in determining the likelihood values for each observation present a practical difficulty. Externally estimated precision (multinomial variances for length compositions, or jackknife estimates for abundance indexes) are much more precise than the model is capable of fitting. For example, year effects from a delta-GLM may be quite precise, indicating that the GLM provides a good description of the patterns of variability in the data. However, unlike the independent treatment in the GLM, the year-to-year abundances in the model are very constrained by age structure, so that annual values are not independent. In recent years it has become customary to adjust the precision of the length composition and abundance indexes to approximately match the goodness of fit that can be achieved by the model.

Two initial model runs, corresponding to STATb1 and STATb2 (but also including the three recruitment indexes), was run with length composition sample sizes set to actual values (with a maximum of 300), and with the annual CVs of the abundance indexes set to 0.5. The results of these "tuning models" were used in the following calculations.

Effective Sample Size: An empirical estimate of "effective" sample size (N_{eff})is provided by the synthesis model, based on the ratio of the variance of the expected proportion (p) from a multinomial distribution to the mean squared error of the observed proportion (p'), i.e., $N_{eff} = sum[p(1-p)]/sum[(p-p')^2]$. Rather than direct use of N_{eff} (e.g., McAllister and Ianelli, 1997), this assessment follows the regression "smoothing" approach developed in the 1999 bocaccio assessment: Actual sample sizes are replaced by nominal effective sample sizes based on the predicted effective sample sizes from a regression of N_{eff} on actual number of fish measured, or actual number of sample clusters, whichever appeared to provide the more consistent relationship. Alternative regressions included zero-intercept, non-zero-intercept, and hockey stick forms according to the pattern of underlying points. The two tuning models produced nearly identical effective sample sizes. The relationships between actual and tuning model effective sample sizes, with fitted regressions, are shown for various sources in Figure 24; details are given in Table 2.

Precision of Abundance Indexes: The root mean squared error (RMSE) was calculated for each abundance index (Table 3). Values of RMSE are approximately equivalent to coefficients of variation (CVs) for purposes of comparison. In subsequent models, the precision of the abundance indexes was set equal to the average RMSE of the two models. Use of a common data set facilitated subsequent comparison of likelihood values. The very high RMSE values for the three recruitment indexes was the basis for excluding their use in further models.

<u>Model Results:</u> Selectivity curves are nearly identical for the three models, and results for the STATc model are shown here (Figure 25). The curves are generally dome-shaped, and are freely estimated. Previous assessments have found that the selectivity curve for the Triennial Survey is poorly determined, and that remains the case in this assessment, despite deletion of the length compositions from 1977-1986. Fits to the surveys (Figure 26) are generally reasonable, except for a poor fit to the Triennial Survey. Although the models tend to show a recent increase in abundance, the magnitude of increase is smaller than suggested by the recreational CPUE indexes. Fits to the length compositions are shown by "bubble plots" (Figure 27). There appear to be periods during which fish are consistently larger of smaller than expected. One likely cause is unmodeled interannual variability in growth rates.

The historical spawning output (Figure 28) and historical total abundance (Figure 29) vary similarly to those in the 2002 bocaccio assessment, except that the low values in the 1990s are not as extreme, and a population increase is beginning to appear in 2000-2003. The STARb2 model shows a different pattern of early abundance because of differences in assumed recruitment (constant through 1969). Recruitment estimates are generally unreliable before 1970, but more recent years show a clear pattern of isolated strong year classes (Figure 30). A comparison of year class strengths estimated by the STARb1 and STARb2 models show that the estimated size of the 1999 year class is one of the main differences between the two models (Figure 31). The STATc estimate is intermediate. The history of exploitation rates is shown in Figure 32. Fishing intensity greatly exceeded what we now (in hindsight) consider to be an optimal harvest rate (the PFMC uses F50% as a proxy for Fmsy). Overfishing ended in 1998, and under rebuilding, harvest rates have declined to about one-half Fmsy. Numerical values of estimated population parameters are given in Appendix 1.

Comparison with Previous Stock Assessments: Four “complete” assessments have been done for bocaccio (Ralston et al. 1996, MacCall et al. 1999, MacCall 2002 , and this 2003 assessment). Year 1969 was the first year for abundance estimates in the 1996 and 1999 stock assessments, while 1951 was used in the 2002 and 2003 assessments. Results of these four assessments are shown in Figure 33. For purposes of comparability, spawning outputs are expressed relative to an unfished biomass estimated from the average recruitment in 1969 to 1986 and the unfished spawning output per recruit estimated in each assessment. The 1999 and 2002 assessments assumed M=0.2, generating higher initial biomass estimates and steeper declines, with 1969 biomass estimated as being near the estimated unfished level. This 2003 assessment returns to the M=0.15 assumption used in the 1996 assessment, and these two assessments show less relative decline since 1969, but the initial 1969 abundance is estimated to be only about 60% of the unfished level.

2003 Stock Status and Harvest Levels for 2004: Relative abundance is substantially higher than was indicated by the 2002 assessment, with estimated spawning outputs in the range of 5.6 to 8.5% of the unfished level (Table 4). Spawning output is expected to increase for several years as the 1999 year class approaches full maturity. Harvest levels for 2004 are shown in Table 5. The ABC is calculated based on F50% applied to the estimated 2004 abundance. Abundance is still below 10% of Bunfished, so “40-10" harvest levels are zero for all three models. Rebuilding harvests are described in the bocaccio rebuilding analysis (MacCall 2003), and are summarized here. Constant F rebuilding policies (70% probability of rebuilding on or before Tmax) from the two STAR models provide 2004 harvest levels of 250 to 625 mtons, and the intermediate STATc model gives a value of 306 mtons. Rebuilding times are much shorter than were seen in the 2002 assessment, mainly because of the much stronger estimated 1999 year class and generally higher productivity rates estimated by the 2003 models. The interaction of alternative management actions with possible “true” models (STARb1, STARb2, STATc) forms a decision table (Table 6). This decision table considers only rebuilding options with 70% probability of success on or before Tmax, and under each management action sets a constant harvest rate corresponding to the catch in the first year. Table 7 shows the level of effort, relative to that in 2002, that will achieve alternative harvest rates, based on model STATc.

Sensitivity Analyses: The STATc model was used to explore alternative emphasis values for individual likelihood components (Table 8). As suggested by the differences between the STARb1 and STARb2 models, the recreational data (both CPUE and length compositions) tend to favor higher estimates of abundance. The Triennial Survey length compositions indicate the presence of the 1999 year class (that component is neutral), but the Triennial Survey abundance component tend to favor lower estimates of current abundance. The STATc model was also used to explore effects of alternative assumed natural mortality rates (Table 9). Estimated current biomass is insensitive to the assumed natural mortality rate, but their effect on estimated unfished abundance (Bunfished) is strong (low M results in a larger unfished biomass per recruit).

Estimates of relative abundance vary from 5.4% of Bunfished if M is low, to 9.1% of Bunfished if M is high.

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Table 1a. Historical bocaccio catches (mtons), 1950-1999

Year	Foreign	Trawl	Hook&Line	SetNet	TOT Comm	RECso	RECno	TOT Rec	TOTAL
1950		1287	200		1487	39	86	126	1613
1951		1738	277		2015	35	98	134	2148
1952		1691	276		1966	45	86	131	2097
1953		1921	321		2241	56	72	129	2370
1954		1979	337		2317	122	91	212	2529
1955		2034	290		2324	213	108	321	2646
1956		2383	356		2739	256	121	377	3116
1957		2584	365		2949	138	120	258	3207
1958		2621	649		3270	95	193	289	3559
1959		2236	565		2801	57	160	218	3019
1960		2163	351		2514	63	125	188	2701
1961		1631	354		1985	72	94	166	2151
1962		1316	343		1659	68	109	177	1836
1963		1939	386		2325	67	111	178	2503
1964		1229	259		1488	94	85	179	1667
1965		1417	305		1722	117	132	249	1971
1966	1101	1513	332		2946	170	142	312	3258
1967	2857	1468	328		4653	210	140	350	5003
1968	909	1410	321		2640	223	166	389	3029
1969	48	1388	304		1739	212	154	366	2105
1970		1660	298		1959	289	204	493	2451
1971		1624	424		2047	244	167	411	2458
1972	48	2412	598		3058	339	226	565	3623
1973	1987	4046	1040		7073	401	260	660	7733
1974	3907	3061	778		7746	459	289	748	8494
1975	1070	3142	812		5024	450	276	726	5750
1976	1021	2948	776		4745	417	248	665	5410
1977		2172	581		2754	377	218	595	3348
1978		2785	345	142	3272	350	196	546	3818
1979		2963	387	161	3511	445	242	687	4198
1980		3643	310	151	4104	1755	178	1932	6036
1981		3977	441	296	4714	841	230	1070	5784
1982		4302	748	314	5365	1158	358	1516	6881
1983		4361	380	551	5292	265	301	566	5858
1984		3269	309	398	3976	177	67	244	4220
1985		1268	126	852	2246	321	66	387	2633
1986		1183	328	945	2456	428	171	599	3055
1987		1179	321	1081	2581	90	103	192	2773
1988		1252	463	368	2083	107	44	151	2233
1989		1146	391	971	2508	179	78	256	2764
1990		1124	344	659	2127	233	91	324	2451
1991		706	177	442	1325	200	92	292	1617
1992		488	464	570	1523	167	92	260	1783
1993		559	402	413	1373	109	19	128	1502
1994		526	208	270	1005	215	5	220	1224
1995		377	70	283	730	44	3	47	777
1996		288	97	95	480	67	26	93	573
1997		230	58	36	324	49	107	157	480
1998		73	45	39	157	29	23	51	208
1999		45	21	7	73	71	53	124	197

Table 1b. Historical bocaccio landings and estimated catches (mtons), 2000-2002

Year	Trawl	Hook&Line	SetNet	TOT Comm	RECso	RECno	TOT Rec	TOTAL
Reported Landings								
2000	20	7	1	28	52	60	112	140
2001	14	8	1	23	60	49	109	132
2002	18	3	0	21	76	8	84	105
Estimated Catch								
2000	54	19	2	76	52	60	112	187
2001	37	23	2	62	60	49	109	171
2002	99	17	1	116	76	8	84	200

Table 2a. Sample size information for length compositions and Triennial Survey index..

	Recreational Fisheries					Triennial Trawl Survey	
	SoCalRecFin		NoCalRecFin		CDF&G		
	intercepts	bags	intercepts	bags	trips	Ntows	Npositive
1977						575	159
1978							
1979							
1980	326	394	255	84		349	98
1981	381	442	131	57			
1982	294	272	165	75			
1983	375	236	180	70		521	116
1984	433	206	314	69			
1985	308	256	654	157			
1986	281	225	610	211		484	85
1987	19	47	220	69	131		
1988	59	32	274	40	246		
1989	297	99	240	60	278	505	96
1990					95		
1991					77		
1992					248	482	42
1993	39	45	51	9	284		
1994	149	97	60	13	284		
1995	25	16	122	36	278	512	47
1996	161	35	498	136	246		
1997	43	10	153	16	236		
1998	184	52	204	40	149	528	37
1999	656	235	626	261			
2000	440	234	233	125			
2001	212	158	148	80		506	31
2002	415	230	111	48			

Table 2b. Samples sizes and effective sample sizes for length compositions.

	Commercial Fisheries									Recreational Fisheries				Triennial Survey	
	TRAWL			HOOK&LINE			SETNET			SoCAL		NoCAL			
year	Nfish	Nsamp	Neff	Nfish	Nsamp	Neff	Nfish	Nsamp	Neff	Nfish	Neff	Nfish	Neff	Nsamp	Neff
1975										21486	157				
1976										26209	173				
1977										11155	122			30	not used
1978	1565	142	106				61	6	19	17988	145				
1979	1448	102	104												
1980	1673	225	108	30	2	3				2577	92	250	45	17	not used
1981	1290	160	101							2227	91	250	45		
1982	2399	242	122	19	2	3				1828	90	310	55		
1983	2675	308	128	55	5	7	44	7	18	706	86	359	64	15	not used
1984	2603	276	126	34	2	3	44	7	18	481	85	183	33		
1985	1658	262	108	34	4	5	274	38	29	1256	88	532	95		
1986	2431	189	123	496	32	42	1566	152	91	1267	88	942	168	17	not used
1987	2876	200	132	274	22	29	1193	101	73	121	84	1136	203		
1988	1822	165	111	147	10	13	1189	86	73	79	79	1264	226		
1989	1112	141	98	399	24	31	1486	128	87	478	85	1537	274	69	47
1990	2133	188	117	141	10	13	950	105	61			974	174		
1991	2525	117	125	253	27	35	508	36	40			866	155		
1992	1630	70	108	641	43	51	1258	59	76			1697	303	35	24
1993	1615	68	107	712	61	80	924	44	60	207	84	1231	220		
1994	1085	45	97	516	31	41	802	41	54	377	85	776	139		
1995	675	34	89	186	11	12	563	28	43	35	35	814	145	47	32
1996	636	31	88	722	44	41	170	7	24	114	84	817	146		
1997	991	45	95	488	24	29	104	4	21	54	54	1759	314		
1998	430	24	84	464	25	21	212	10	26	106	84	937	167	37	25
1999	424	17	84	114	6	8				421	85	637	114		
2000	191	10	80	69	9	12				505	85	282	50		
2001	617	25	88	254	19	24				380	85	324	58	31	21
2002	320	15	82	75	5	1	25	1	17	771	86	180	32		

Table 2c. Sample sizes (Nstations) for CalCOFI larval surveys.

	Cen Cal	So Cal	Mexico
CalCOFI Line	60-73	77-93	97-113
1951		135	
1952		175	
1953		205	
1954		229	
1955		180	
1956		208	
1957		225	
1958		247	
1959		291	
1960		313	
1961		97	
1962		94	
1963		107	
1964		123	
1965		116	
1966		195	
1968		50	
1969		217	
1972	119	176	86
1975	96	306	99
1976	28	115	
1978	124	318	108
1979	86		48
1980	63		23
1981	131	300	129
1982	39		21
1983	40		20
1984	104	189	73
1985	25	91	26
1986		140	
1987		153	
1988		157	
1989		107	
1990		151	
1991	16	151	
1992		103	
1993		108	
1994	13	107	
1995		99	
1996		103	
1997		104	
1998	16	105	
1999		105	
2000		108	
2001		105	
2002		106	
2003	17	31	

Table 3. Precision (RMSE) of abundance indexes from model tuning runs. Values in parentheses receive emphasis of zero, but are reported for comparison.

Component	STARb1	STARb2	Average
North Rec CPUE	0.672	(1.099)	0.67
North DFG CPUE	0.334	0.408	0.37
South Rec CPUE	0.706	(0.903)	0.71
Trawl CPUE	0.377	0.2547	0.32
Triennial Survey	(1.263)	0.808	0.81
CalCOFI	0.659	0.695	0.68
Power Plant Rect	2.154	2.042	2.10
Juvenile Survey Rect	2.118	1.981	2.05
Pier CPUE Rect	3.439	3.139	3.29

Table 4. Estimated spawning abundance and related reference points.

					2003		
MODEL	SPR(F=0)	AvgR51-86	Bunfished	Brebuild	Spawn Out	% of Bunf	% of Brebuild
STARb1	2.500	5364	13412	5365	1136	8.5%	21.2%
STARb2	2.498	5230	13064	5226	733	5.6%	14.0%
STATc	2.499	5358	13387	5355	984	7.4%	18.4%

Table 5. Reference harvest levels and associated rebuilding statistics for 2004.

	2004		REBUILDING SUMMARY				
MODEL	ABC(MT)	C(40-10)	TARGET	OY(70%)	Tmed(70%)	Tmax	Tmin
STARb1	660	0	5365	625	20	25	12
STARb2	400	0	5226	250	25	30	17
STATc	501	0	5355	306	23	28	16

Table 6. Decision table treating three alternative models as true states of nature. Four management decisions are given, corresponding to the correct decision under the three models, and a fourth decision based on average catch from the STARb1 and STARb2 models. Values in bold indicate the correct decision for the associated model if it is true.

	True Model (State of Nature)		
	STARb1	STATc	STARb2
Management Decision:			
STARb1			
C2004	**624.8**	624.7	624.8
F	**0.0801**	0.1039	0.1403
medianTreb(years)	**20.1**	41.6	81.1
Prob Rebuild by Tmax	**70%**	19%	3%
STATc			
C2004	307.2	**306.3**	307
F	0.0387	**0.0498**	0.0669
medianTreb(years)	14.7	**22.7**	28.1
Prob Rebuild by Tmax	94%	**70%**	58%
STARb2			
C2004	250	248.8	**249.6**
F	0.0314	0.0403	**0.0541**
medianTreb(years)	13.9	20.7	**25.2**
Prob Rebuild by Tmax	96%	79%	**70%**

Table 7. Future catches and levels of fishing effort relative to 2002 for alternative constant harvest rates beginning in 2004 (based on STATc model).

C2004(MT)	200	300	400	500	200	300	400	500
F	0.035	0.055	0.0774	0.103*	0.035	0.055	0.0774	0.103*
Year	Catch				Effort rel to 2002 level			
2004	200	300	400	501	84%	131%	182%	240%
2005	199	294	386	475	80%	125%	174%	229%
2006	192	280	363	439	76%	118%	164%	216%
2007	185	267	342	409	72%	112%	156%	206%
2008	182	260	329	389	69%	108%	152%	200%
2009	183	258	324	377	68%	107%	150%	198%
2010	186	260	322	370	68%	107%	150%	198%

* Fmsy

Table 8. Sensitivity of STATc model to alternative emphases on individual components.

	2003 Biomass(age1+) (mtons)		2003 Spawning Output (as percent of unfished)		1999 Year Class Size	
Base Model (STATc)	7133		7.4%		5071	
	EMPH=10	EMPH=0.1	EMPH=10	EMPH=0.1	EMPH=10	EMPH=0.1
Length Compositions						
Trawl	5039	7681	5.2%	7.9%	3674	5216
Hook & Line	6556	7347	6.4%	7.7%	4992	5073
Set Net	5476	7345	5.7%	7.6%	3674	5162
Recreational--South	11994	7391	13.9%	7.4%	6161	5418
Recreational--North	15682	7043	15.3%	7.4%	7344	4955
Triennial Survey	7369	7293	7.8%	7.5%	4887	5190
Abundance Indexes						
RecFIN CPUE--North	18993	5170	17.9%	5.5%	14689	3675
CDF&G CPUE--North	7909	7072	8.2%	7.3%	5490	5006
RecFIN CPUE--South	10596	6470	10.6%	6.7%	7731	4560
Trawl Logbook CPUE	3953	9147	4.0%	9.5%	3051	6263
Triennial Survey	2924	8217	3.1%	8.5%	2232	5776
CalCOFI Larvae	6923	7507	7.0%	7.7%	4887	5190
Group Emphasis:						
Length Compositions	4446		4.7%		3164	
Abundance indexes	9672		8.9%		7985	

Table 9. Sensitivity of STATc model to alternative assumed natural mortality rates.

Model STATc	2003 Biomass(age1+) (mtons)	2003 Spawning Output (as percent of unfished)	1999 Year Class Size
M=0.10	7454	5.4%	4567
M=0.15 (base)	7133	7.4%	5071
M=0.20	7523	9.1%	6099

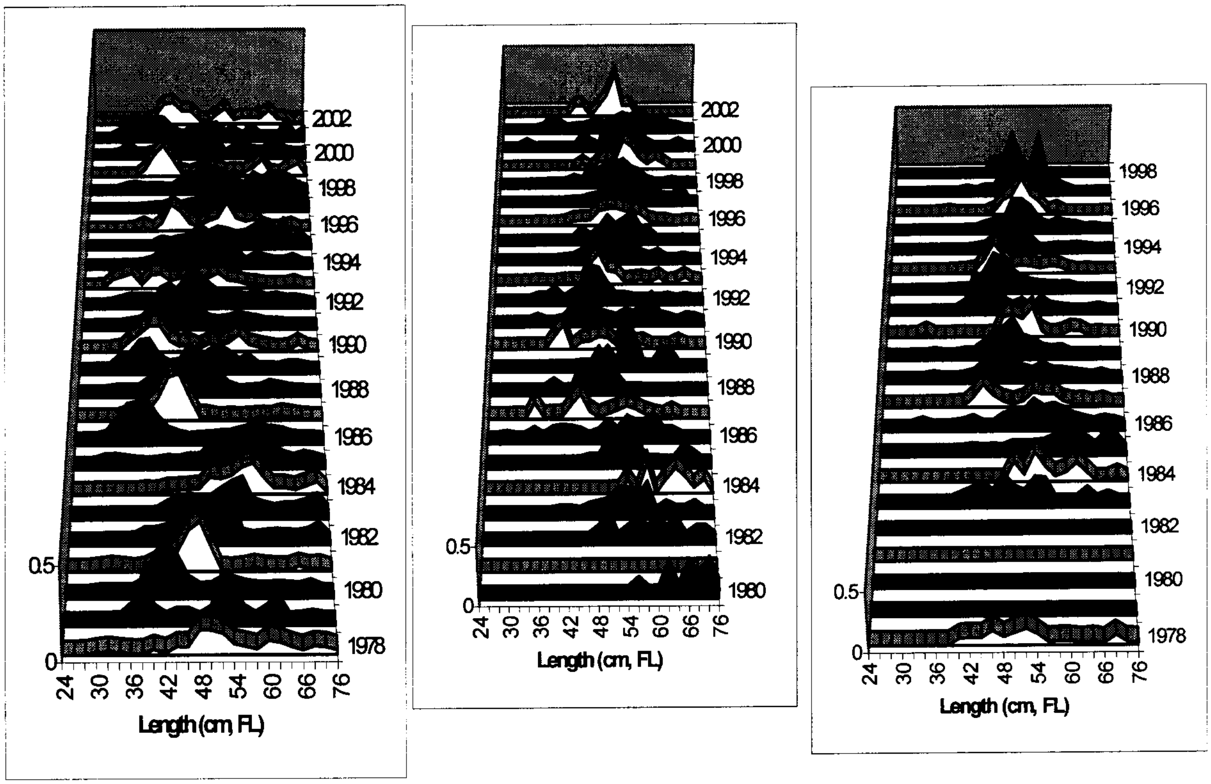

Figure 1. Historical length compositions of female bocaccio landed by commercial fisheries. Left: trawl; Middle: hook and line; Right: setnet.

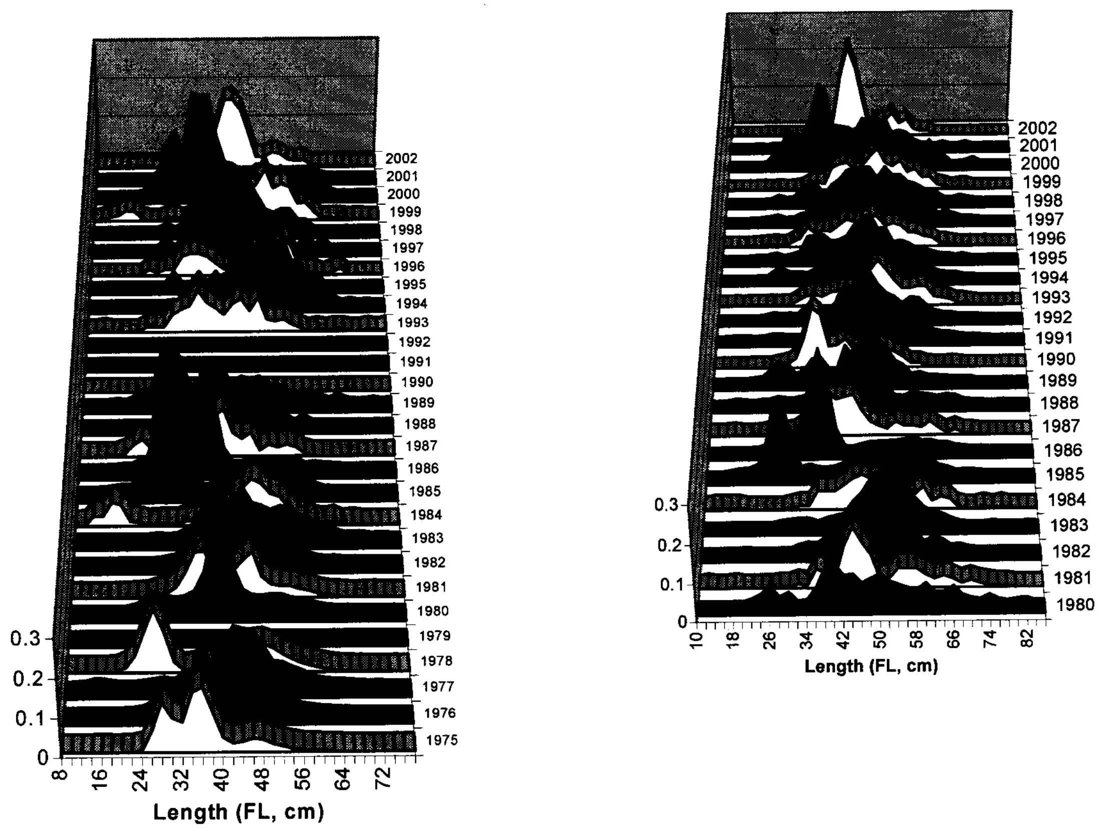

Figure 3. Left is Southern California, right is northern California bocaccio length composition from recreational fisheries, combined

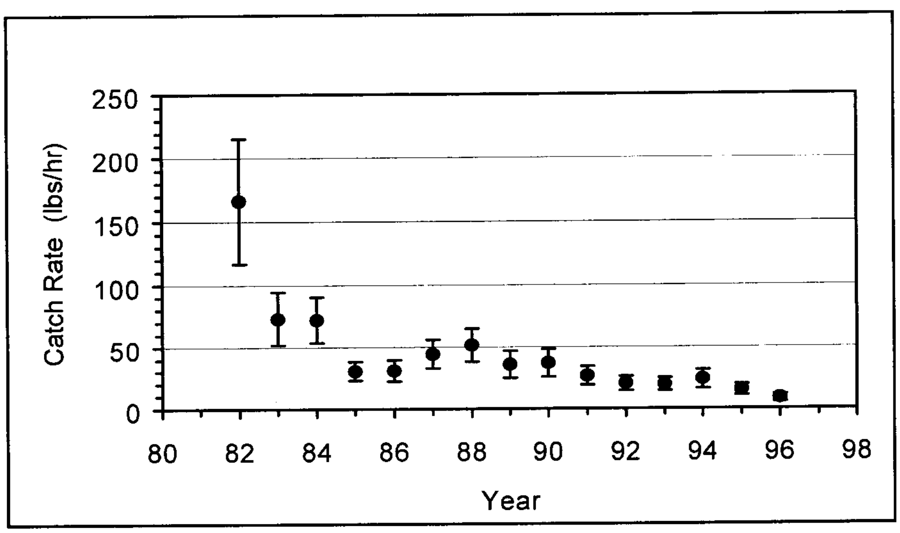

Figure 2. CPUE index of bocaccio abundance from California trawl fishery logbooks (Ralston 1999). Error bars are ±1SE.

sexes.

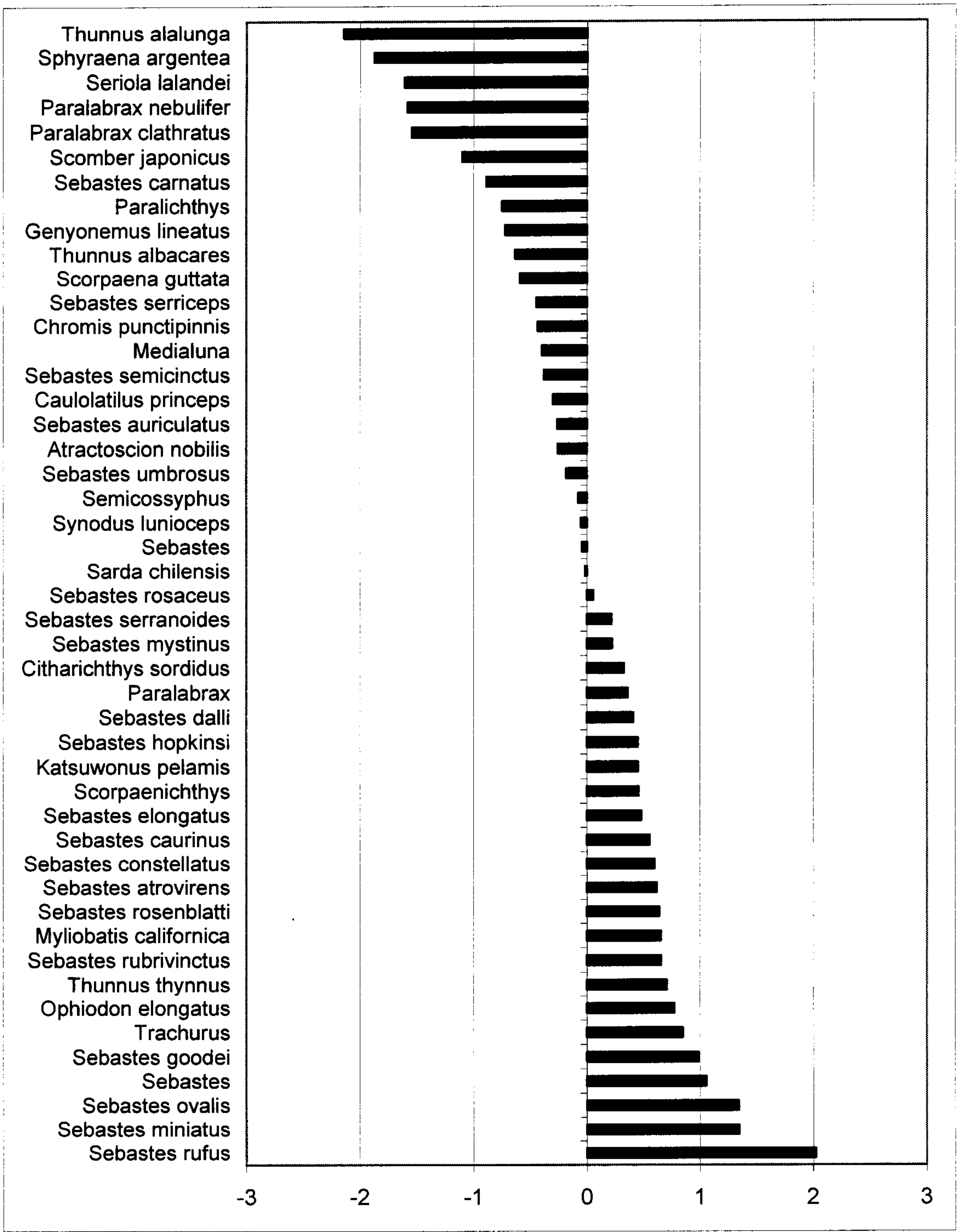

Figure 4. Species coefficients for presence of bocaccio in southern California partyboat catches.

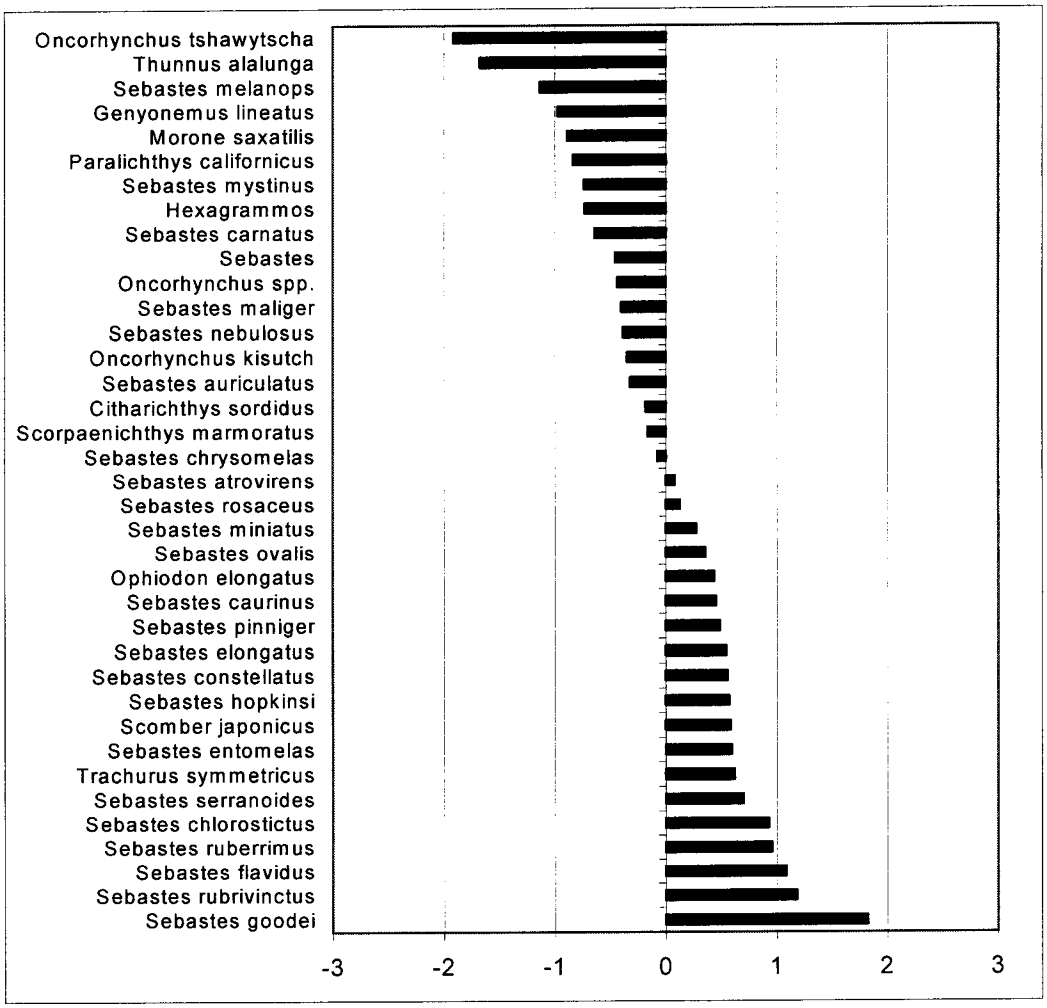

Figure 5. Species coefficients for presence of bocaccio in northern California partyboat catches.

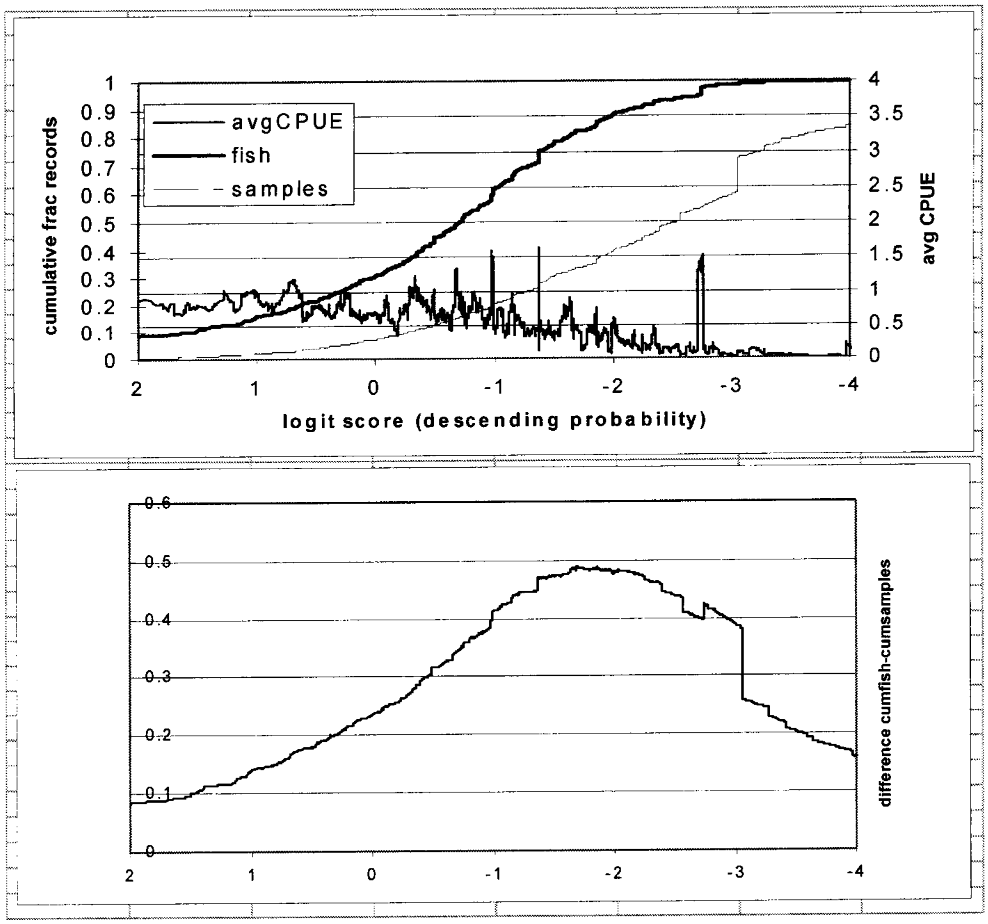

Figure 6. Relationship between northern California bocaccio CPUE (moving average) and logit score based on presence/absence of other species.

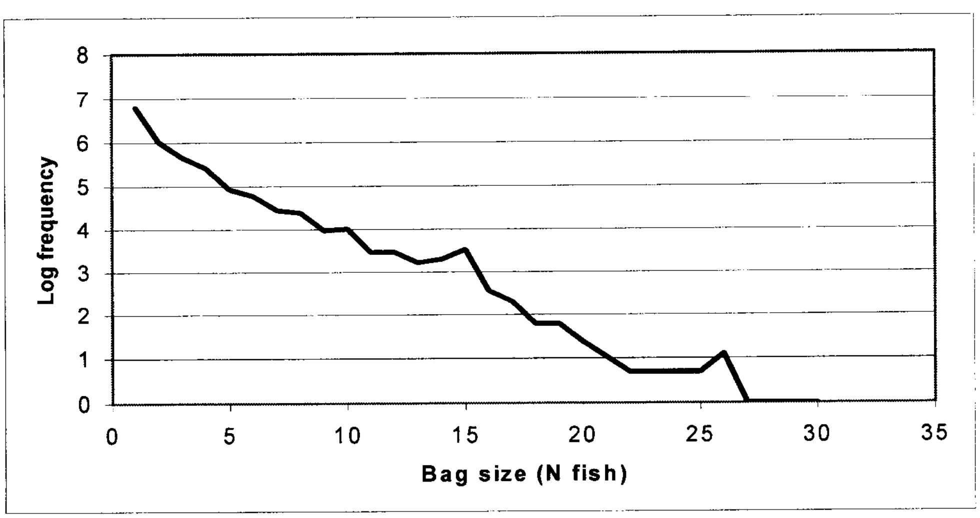

Figure 7. Recreational bag sizes are exponentially distributed. for bocaccio.

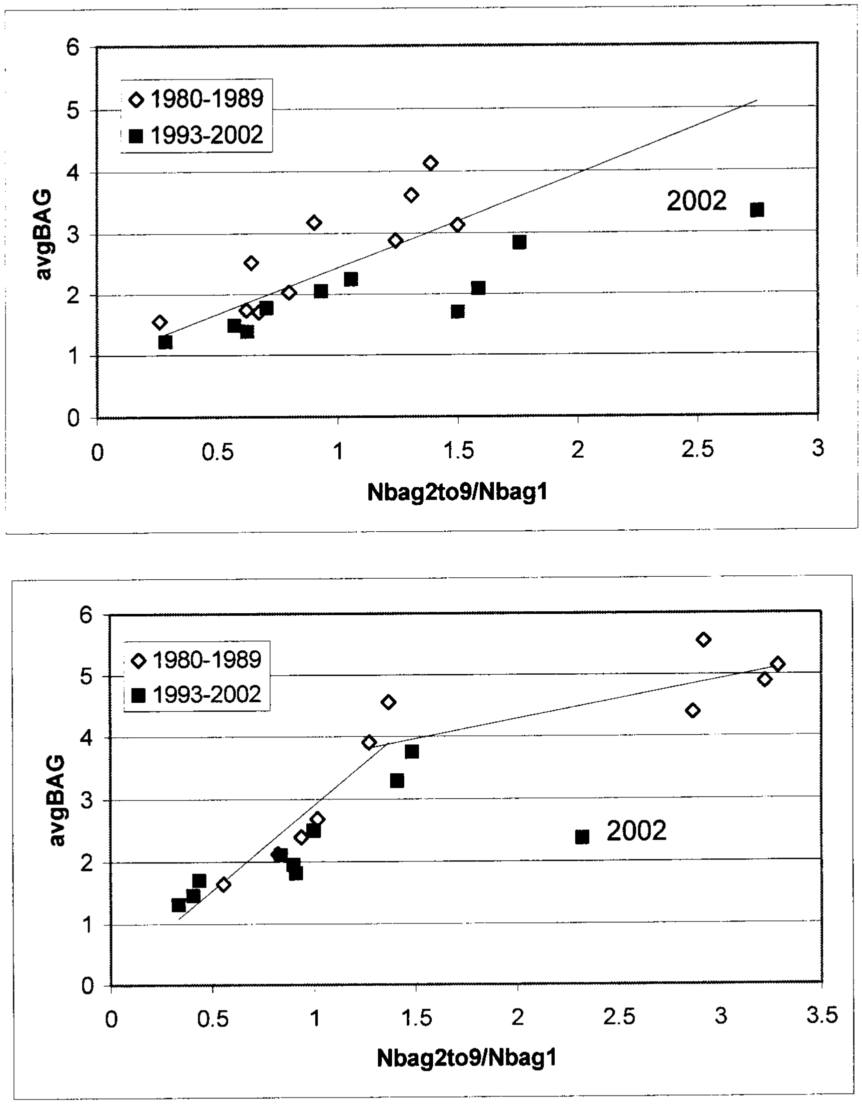

Figure 8. Correction for effects of bocaccio avoidance and reduced bag limits on bocaccio CPUE. Upper is Northern California, lower is Southern California.

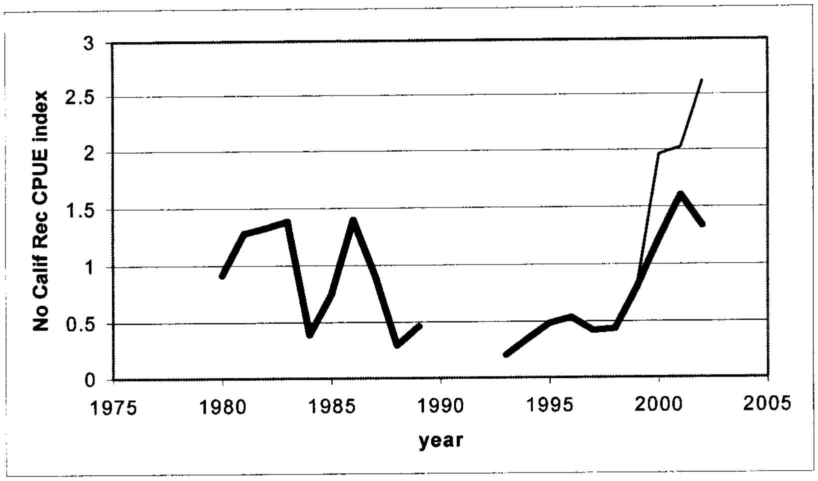

Figure 9. RecFIN-based partyboat CPUE in Northern California. Thin line is value corrected for effect of avoidance and bag limit.

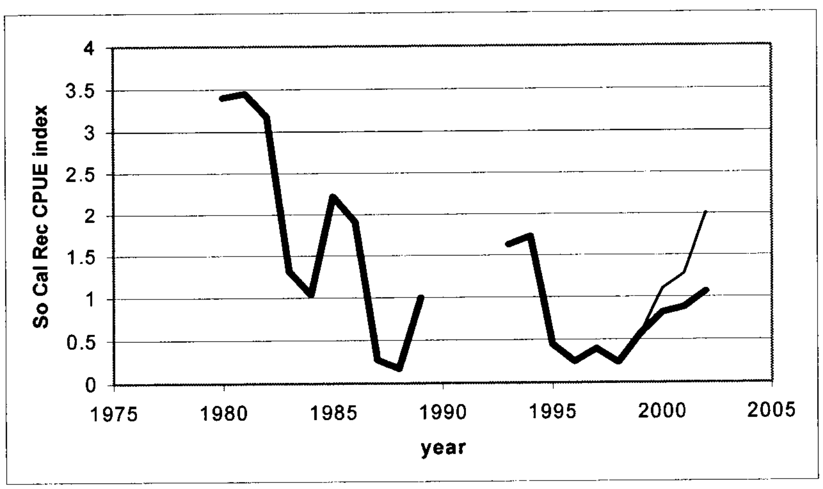

Figure 10. RecFIN-based partyboat CPUE in Southern California. Thin line is value corrected for effect of avoidance and bag limit.

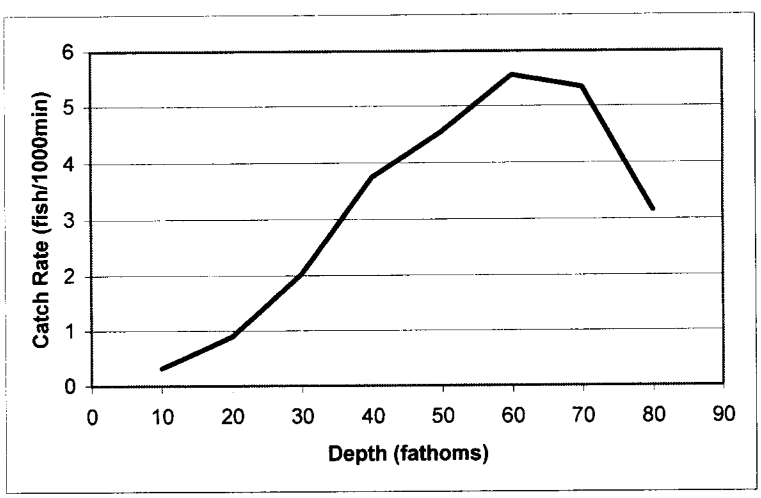

Figure11. Depth effects on recreational catch rate of bocaccio in northern California, as estimated by delta-lognormal GLM

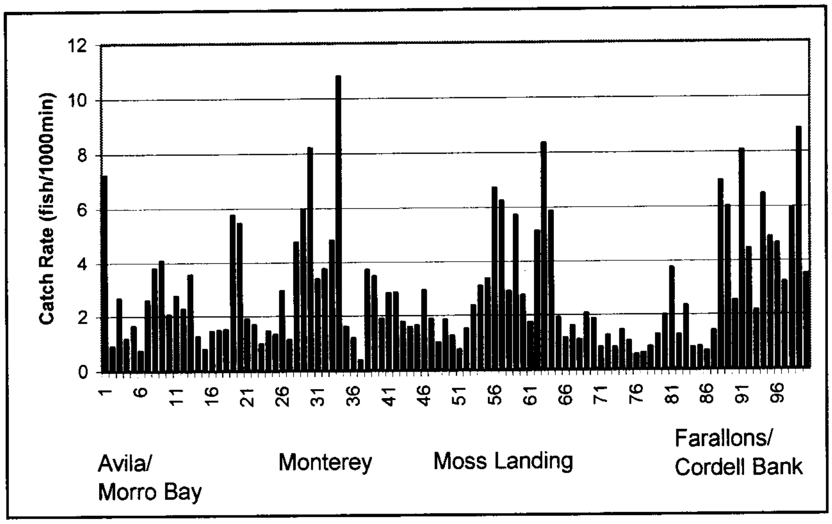

Figure 12. Site effects on recreational catch rate of bocaccio in northern California, as estimated by delta-lognormal GLM

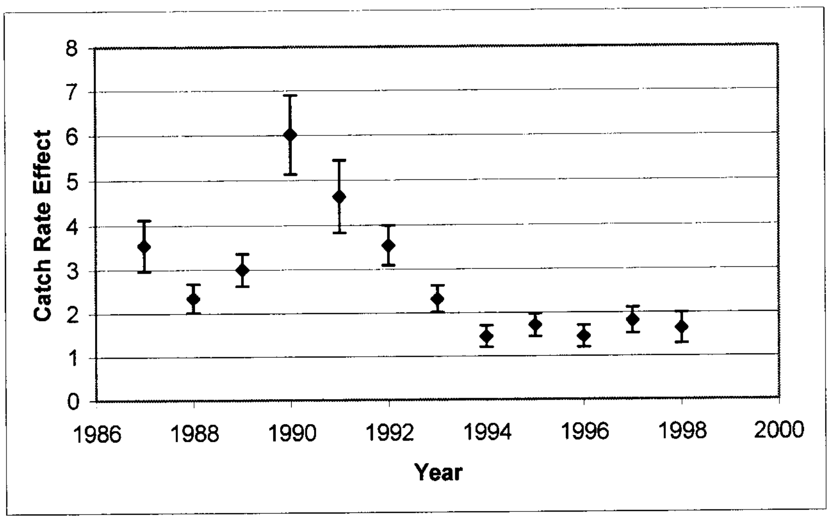

Figure 13. CPUE index from Northern California recreational fishery monitored by CDF&G. Error bars are ±1SE.

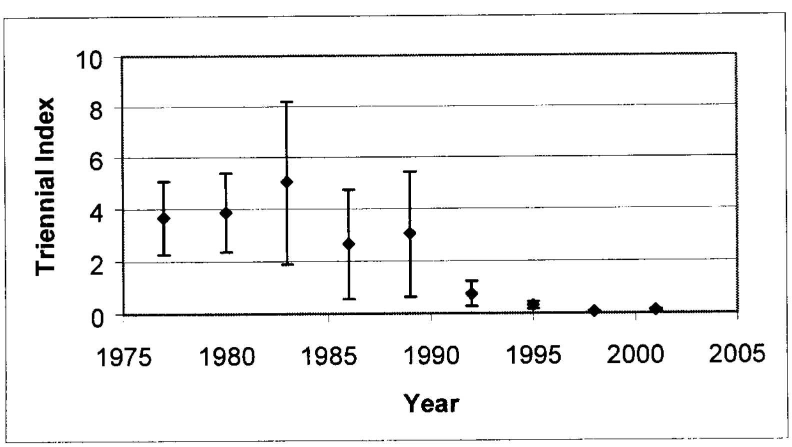

Figure 14. Triennial Trawl Survey GLM index of abundance for Central California (Monterey and Conception INPFC areas). Error bars are ±1SE.

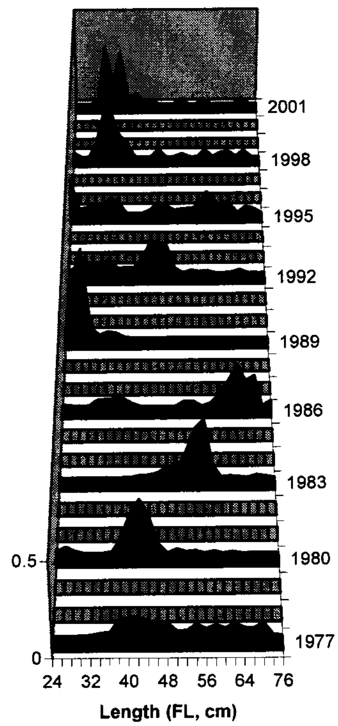

Figure 15. Length composition of female bocaccio sampled by Triennial Surveys. Data from before 1989 were not used in the analysis.

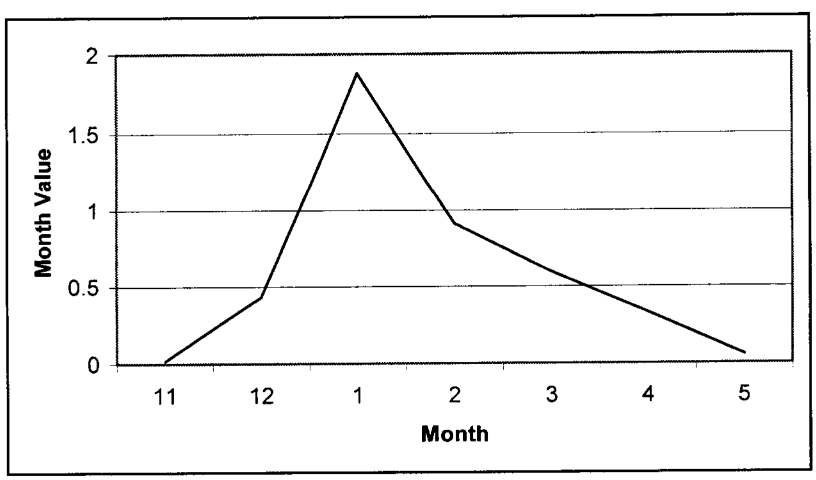

Figure 16. Monthly pattern of bocaccio larval abundance, based on delta-lognormal GLM of CalCOFI samples.

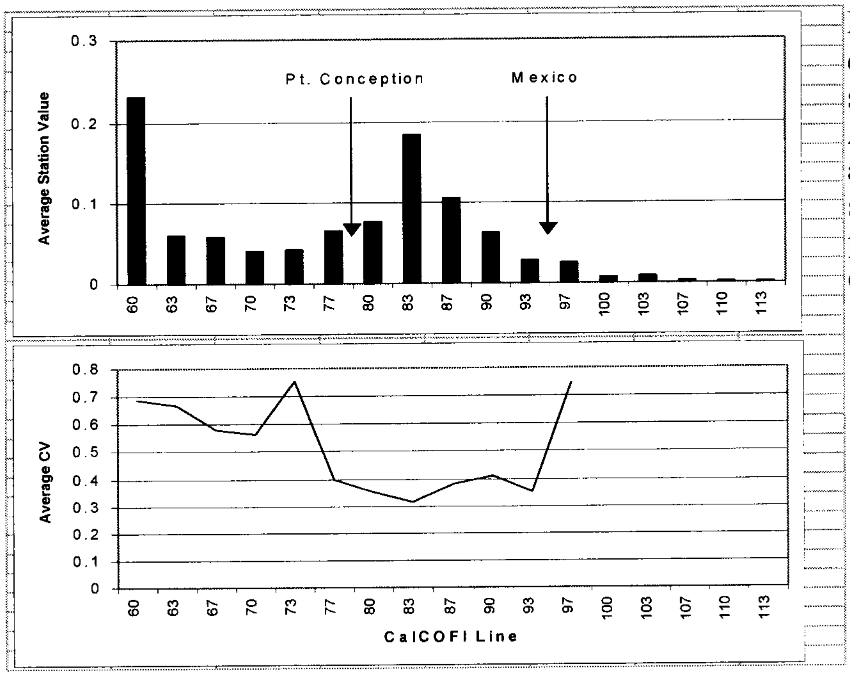

Figure 17. Geographic distribution of bocaccio spawning biomass. Upper: Abundances by CalCOFI line as fraction of total population size. Lower: Relative precision of line-specific estimates

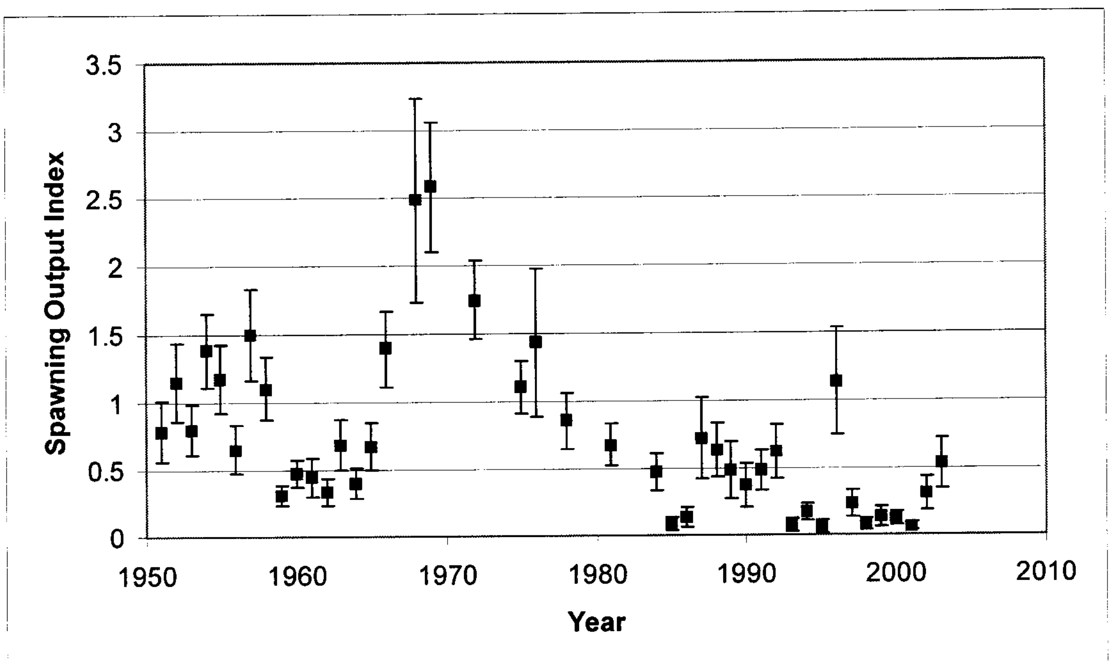

Figure 18. Index of spawning output, based on delta-lognormal GLM of larval abundance observations from CalCOFI surveys. Error bars are ± 1SE, as estimated by jacknife statistic.

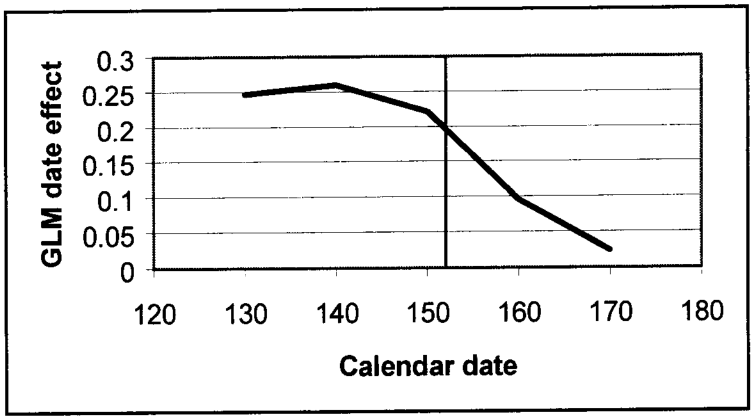

Figure 19. Effect of calendar date on abundance of bocaccio sampled in Central California juvenile rockfish surveys. Vertical line is June 1.

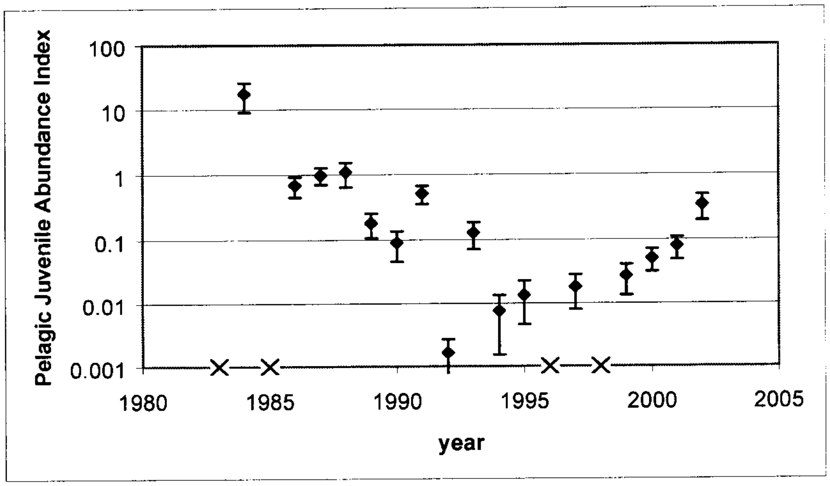

Figure 20. Recruitment strength index based on midwater trawl survey of juvenile rockfish off Central California (error bars are ± 1SE, X denotes years with no catch of juvenile bocaccio).

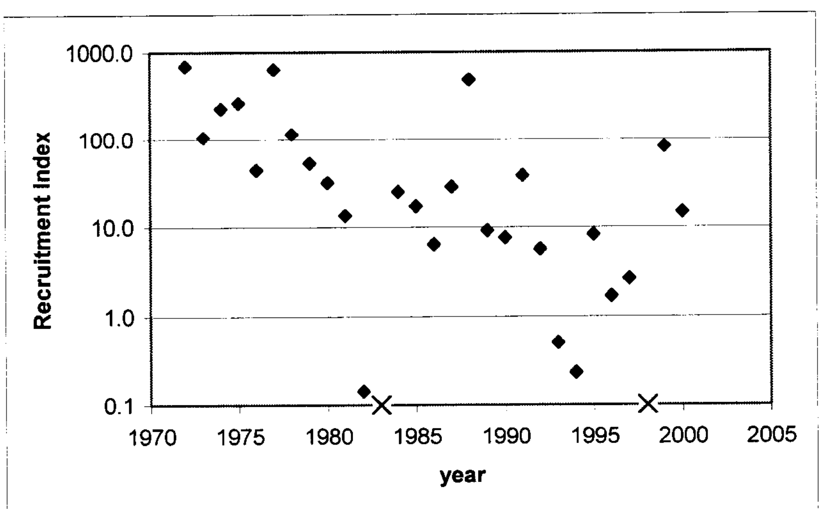

Figure 21. Time series of bocaccio recruitment indexes based on impingement rates at five southern California power plants (data provided by K. Herbinson, Southern California Edison).

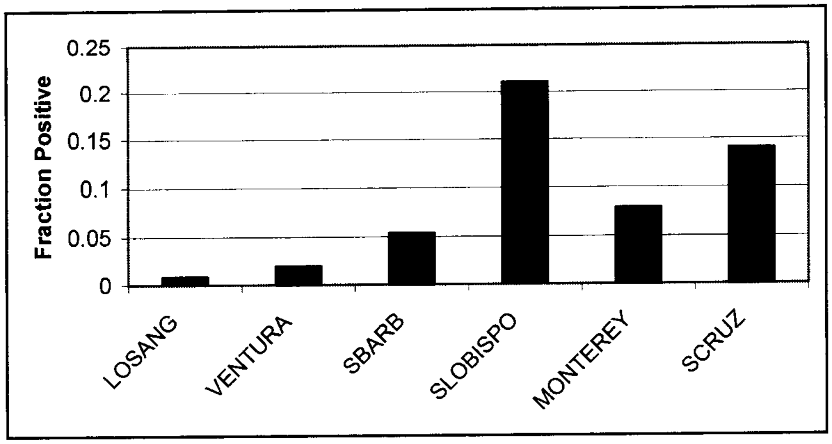

Figure 22. Geographic pattern of occurrence of juvenile bocaccio at fishing piers by California county. Values are zero for Orange and San Diego Counties.

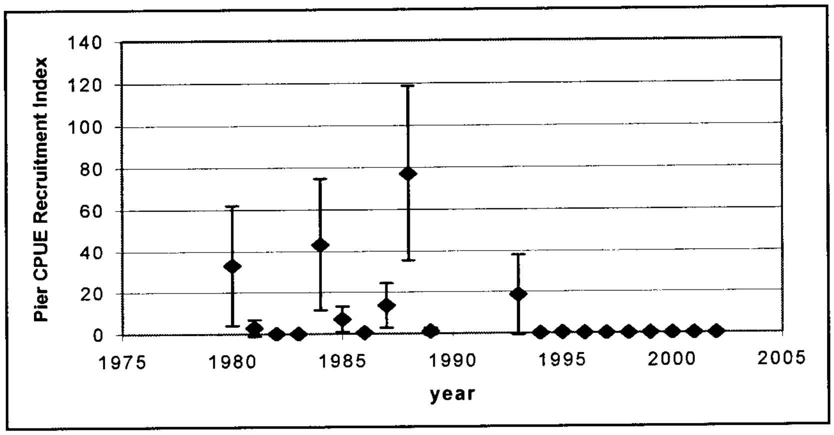

Figure 23. Index of recruitment strength, based on GLM of catch rate of bocaccio from piers. Error bars are ±1SE.

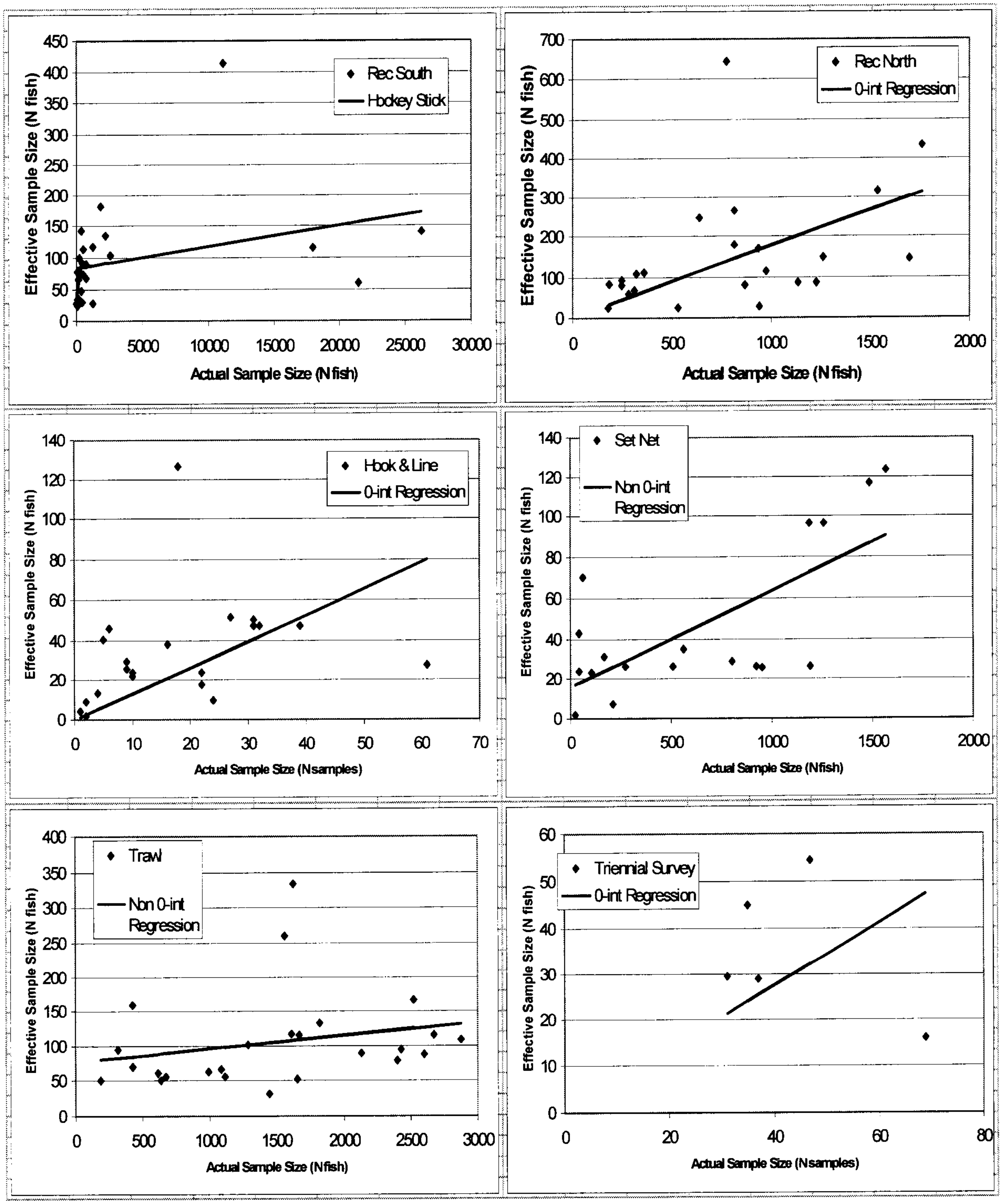

Figure 24. Regression calculations of effective sample sizes for length compositions.

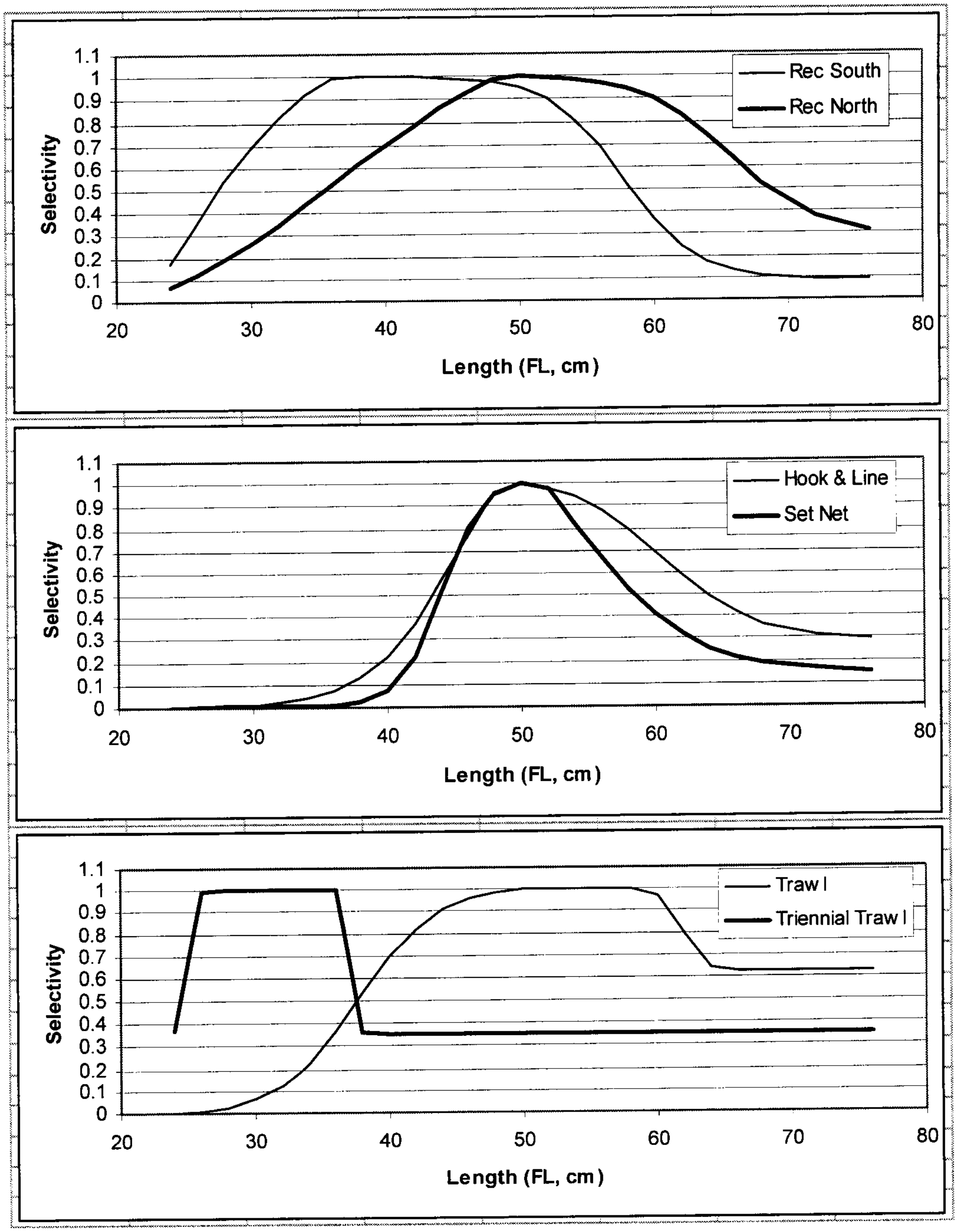

Figure 25. Selectivity curves estimated by the STATc model.

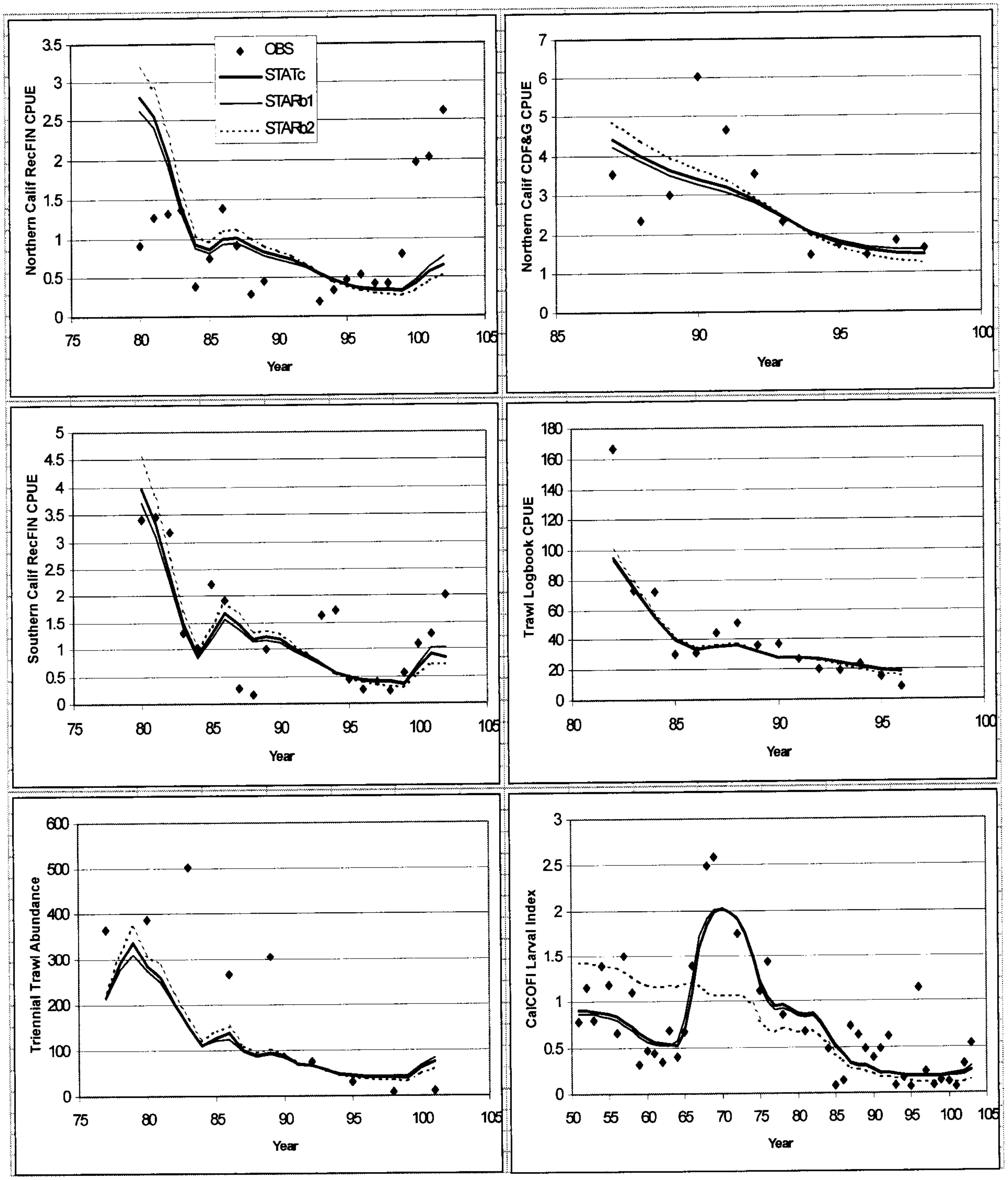

Figure 26. Model fits to abundance indexes.

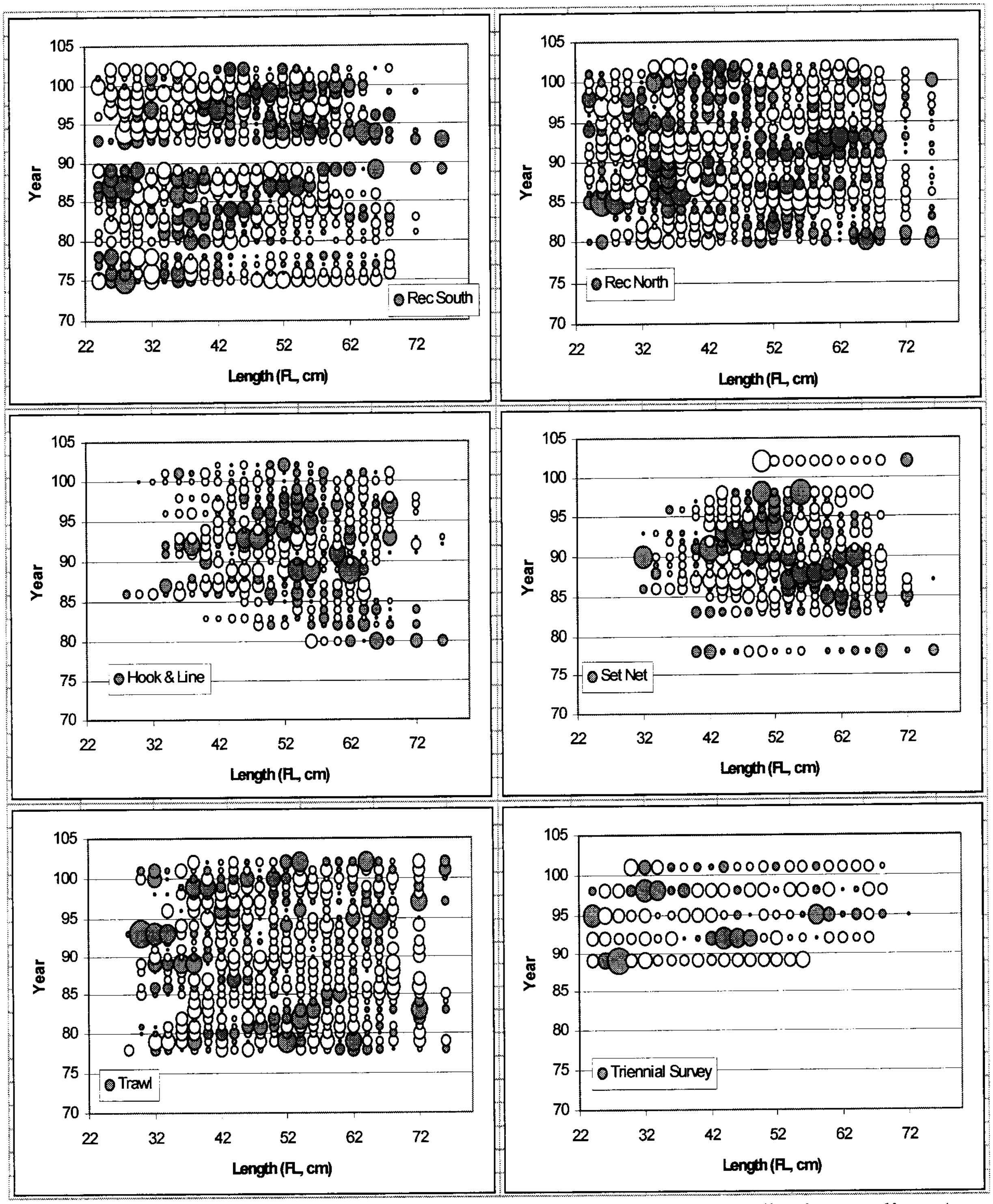

Figure 27. Goodness of fit to length compositions, represented as standardized anomalies. Area of circle is proportional to size of anomaly, colored circles are positive, white circles are negative.

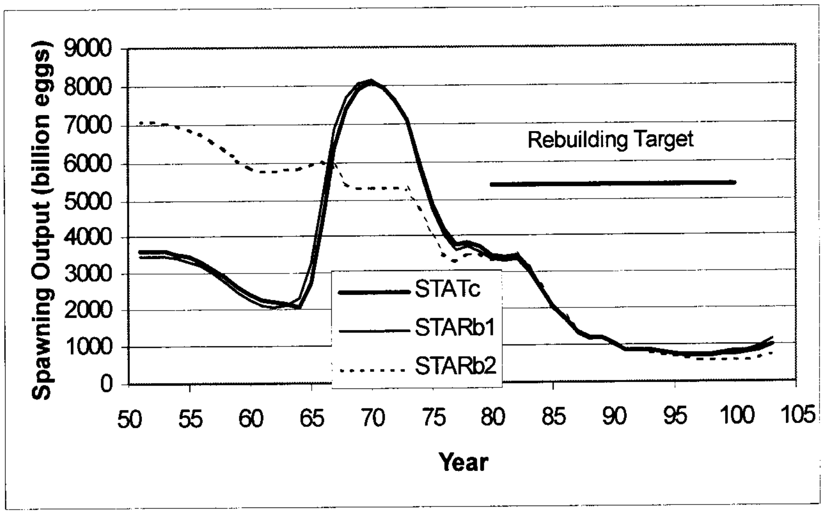

Figure 28. Historical values of spawning output estimated by the three bocaccio models. Rebuilding target is shown for STATc, but others are nearly indistinguishable.

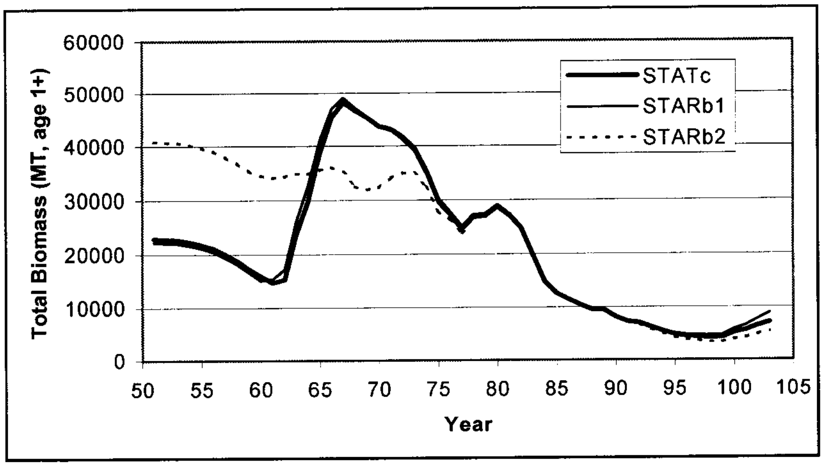

Figure 29. Historical values of total biomass (age 1+) from the three bocaccio models.

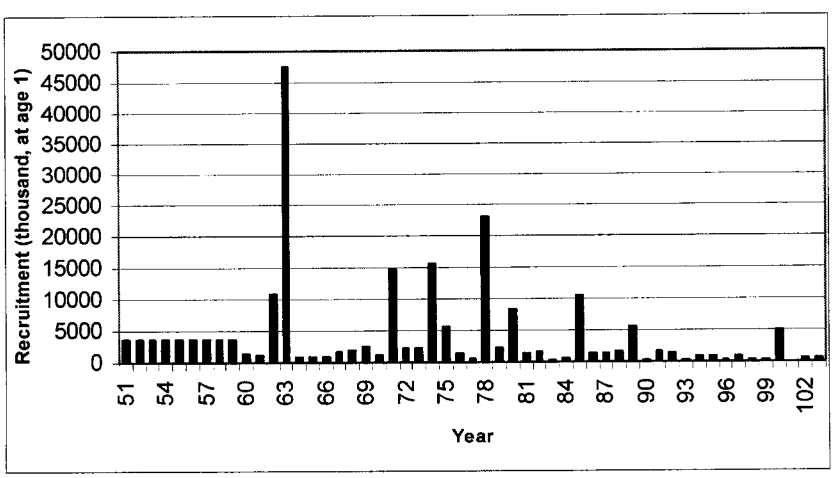

Figure 30. Historical values of recruitment (at age 1) from the STATc model.

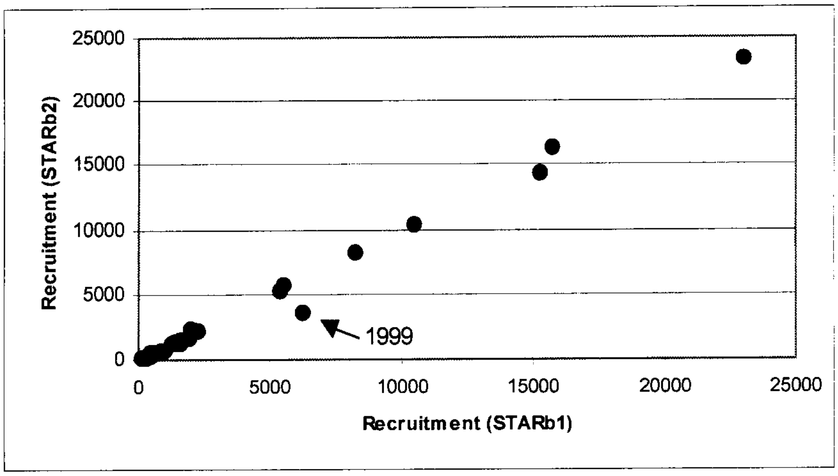

Figure 31. Comparison of recruitments estimated by STARb1 and STARb2 for the years 1971-2000.

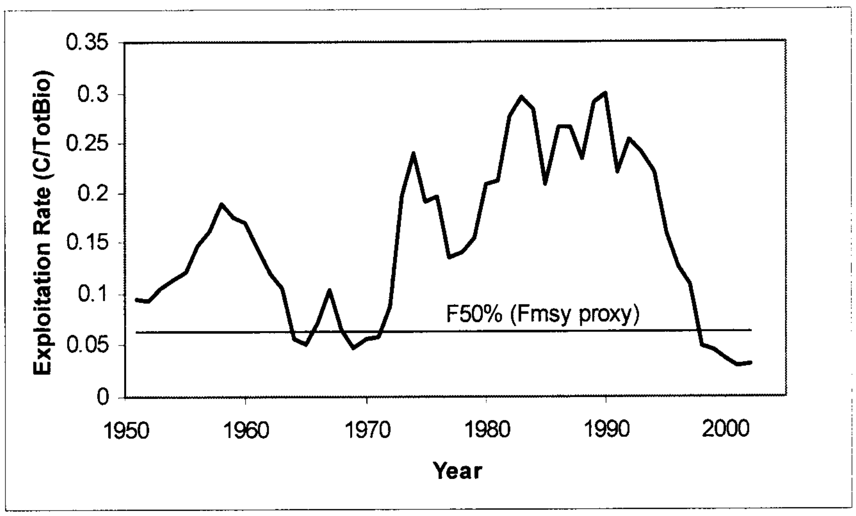

Figure 32. Historical bocaccio exploitation rates (catch/total biomass) relative to the Fmsy proxy of 50% SPR.

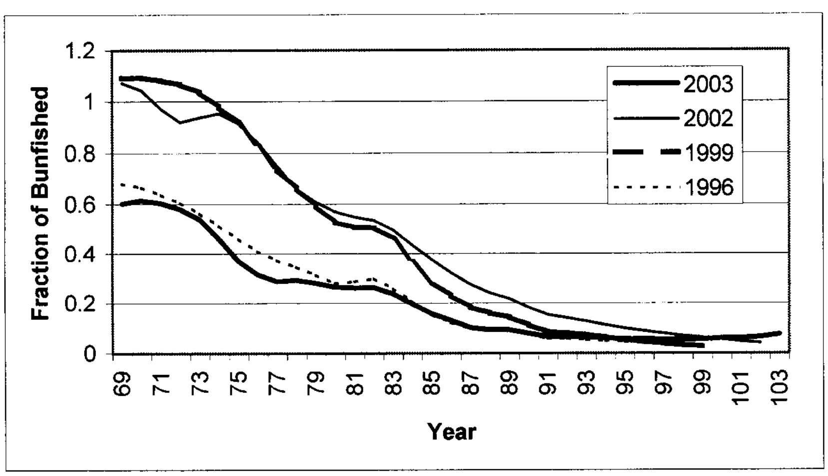

Figure 33. Comparison of results from four recent bocaccio stock assessments, scaled to a common definition of unfished spawning output based on average recruitment from 1969 to 1986.

Appendix 1. Results of bocaccio model STATc.

Year	Bage1+(MT)	SpOut(109eggs)	Recruits(103)	Catch(MT)	ExploitRate
pre-1951	22924	3630	3523	2000	8.7%
1951	22924	3630	3523	2148	9.4%
1952	22779	3611	3523	2098	9.2%
1953	22683	3597	3523	2370	10.4%
1954	22311	3536	3523	2529	11.3%
1955	21775	3446	3523	2645	12.1%
1956	21118	3335	3523	3116	14.8%
1957	19984	3138	3523	3207	16.0%
1958	18781	2909	3523	3558	18.9%
1959	17268	2617	3523	3018	17.5%
1960	15967	2413	1259	2702	16.9%
1961	14732	2273	1135	2151	14.6%
1962	15365	2217	10756	1836	11.9%
1963	23727	2165	47503	2503	10.5%
1964	29740	2066	785	1667	5.6%
1965	38660	2690	711	1971	5.1%
1966	45401	4404	898	3258	7.2%
1967	48187	6368	1574	5003	10.4%
1968	46676	7382	2059	3029	6.5%
1969	45377	7892	2432	2106	4.6%
1970	43676	8073	1161	2451	5.6%
1971	43164	7928	14610	2459	5.7%
1972	41693	7617	2134	3623	8.7%
1973	39585	7073	2143	7734	19.5%
1974	35400	6026	15665	8494	24.0%
1975	30039	4864	5527	5750	19.1%
1976	27606	4153	1252	5410	19.6%
1977	24888	3780	507	3348	13.5%
1978	27121	3845	22964	3818	14.1%
1979	27315	3696	2278	4198	15.4%
1980	28918	3477	8213	6037	20.9%
1981	27262	3433	1423	5785	21.2%
1982	24862	3449	1549	6880	27.7%
1983	19833	3109	149	5858	29.5%
1984	14851	2587	597	4220	28.4%
1985	12634	2074	10436	2633	20.8%
1986	11495	1718	1450	3055	26.6%
1987	10430	1337	1333	2774	26.6%
1988	9561	1216	1529	2234	23.4%
1989	9505	1217	5501	2765	29.1%
1990	8190	1040	179	2451	29.9%
1991	7327	866	1799	1617	22.1%
1992	7038	870	1455	1781	25.3%
1993	6240	838	380	1502	24.1%
1994	5530	780	804	1224	22.1%
1995	4896	738	728	777	15.9%
1996	4560	721	408	573	12.6%
1997	4429	711	901	480	10.8%
1998	4260	704	216	209	4.9%
1999	4330	734	342	197	4.5%
2000	5166	764	5071	187	3.6%
2001	5702	790	50	171	3.0%
2002	6506	843	517	201	3.1%
2003	7133	984	553		

Appendix 1, cont. Results of bocaccio model STATc.

	FEMALES							MALES			
AGE	BEGWT	MIDWT	MATURE	EGGS	SPAWN	N 103	RELATIVE F	BEGWT	MIDWT	N 103	RELATIVE F
1	0.174	0.223	0.002	0.232	0.000	276.3	0.166	0.176	0.223	276.3	0.167
2	0.367	0.499	0.020	0.240	0.002	221.2	0.501	0.351	0.463	221.2	0.466
3	0.711	0.878	0.140	0.253	0.026	18	0.792	0.637	0.770	18	0.725
4	1.127	1.313	0.419	0.269	0.131	1513.5	0.965	0.961	1.101	1519.9	0.906
5	1.580	1.771	0.702	0.286	0.325	83.3	0.987	1.294	1.430	83.9	0.995
6	2.039	2.227	0.869	0.304	0.547	42.8	0.903	1.615	1.742	43.2	1.000
7	2.485	2.663	0.943	0.321	0.762	146.2	0.775	1.911	2.025	146.9	0.958
8	2.905	3.071	0.974	0.337	0.965	52.9	0.647	2.176	2.276	53.1	0.898
9	3.294	3.446	0.987	0.353	1.160	73.1	0.545	2.408	2.495	73.3	0.833
10	3.648	3.783	0.993	0.367	1.345	60.3	0.477	2.607	2.681	60.2	0.772
11	3.958	4.074	0.996	0.380	1.513	20.1	0.436	2.777	2.839	20.2	0.717
12	4.222	4.319	0.997	0.391	1.659	52	0.411	2.919	2.972	52	0.671
13	4.442	4.522	0.998	0.399	1.781	41.9	0.396	3.039	3.082	41.2	0.633
14	4.624	4.690	0.998	0.405	1.882	2.6	0.386	3.138	3.174	2.5	0.602
15	4.774	4.828	0.999	0.410	1.965	51	0.379	3.220	3.250	45.1	0.578
16	4.895	4.939	0.999	0.414	2.032	9.1	0.373	3.289	3.313	7.3	0.559
17	4.993	5.028	0.999	0.417	2.086	5.1	0.369	3.345	3.365	3.7	0.545
18	5.072	5.100	0.999	0.419	2.129	3.6	0.366	3.391	3.408	2.3	0.533
19	5.135	5.157	0.999	0.421	2.163	17.5	0.364	3.429	3.442	9.9	0.524
20	5.185	5.203	0.999	0.422	2.191	0.6	0.362	3.460	3.471	0.3	0.517
20+	5.323	5.328	0.999	0.425	2.265	14.8	0.357	3.557	3.560	3.9	0.501

SPR(F=0) = 2.499   F(50%SPR) = 0.103   Catch/Total Biomass at 50% SPR = 0.0638
Average unfished spawning output = 13387 Total biomass at 40% of average unfished spawning output = 39,255 MT
MSY (est by applying F50% at B40%) = 2504 MT

Relative fishing intensity by gear in 2002:
Trawl 32%, Hook&Line 15%, Set Net 2%, Recreational South 36%, Recreational North 15%

Appendix 2. Stock Synthesis parameter file for model STATc.

```
starcor.csv       LOOP1: 20  LIKE: -1554.34222  DELTA LIKE:      .00975 ENDBIO:      7133.
postcorr.r03
postcorr.P03
2003 assessment postSTAR include all & 0.1srr, rconst to 59 (correct ogive)
     10.000000        .000100     BEGIN AND END DELTA F PER LOOP1
  3   .95                  FIRST LOOP1 FOR LAMBDA & VALUE
  1.100                    MAX VALUE FOR CROSS DERIVATIVE
  1 READ HESSIAN
STARB2.hes
  1 WRITE HESSIAN
STARB2.hes
    .001                   MIN SAMPLE FRAC. PER AGE
  1  21   1  21            MINAGE, MAXAGE,  SUMMARY AGE RANGE
   51   103                BEGIN YEAR, END YEAR
 1       12  0  0  0       NPER, MON/PER
1.00                       SPAWNMONTH
 5  9 NFISHERY, NSURVEY
 2 N SEXES
 50000.  REF RECR LEVEL
 0 MORTOPT
    .150000     .010000      .250000 'M                '   0     1  0      .000000   .0000 !   1 NO PICK
 -999.000000     .010000     1.000000 'M SAME FOR M+F   '   0     1  0      .000000   .0000 !   2 NO PICK
  TRAWL     TYPE:  1
 7 SELECTIVITY PATTERN
  0   0   0   2   0   0    0  AGE TYPES USED
    1.00000         .10 ' TWL CATCH BIOMASS   '  ! # =  1 VALUE:        .00000
    1.00000         .30 ' TWL  SIZE COMPS     '  ! # =  2 VALUE:     -516.47325
 1  1  0  0   0  0  SEL. COMPONENTS
  49.984716   20.000000   70.000000 'Trawl:transition'   2     1  0      .000000   .0000 !   3 OK
    .000001     .000001    1.000000 'Trawl:InitSelect'   0     1  0      .000000   .0000 !   4 NO PICK
    .523932     .001000    1.000000 'Trawl:SmlInflect'   2     1  0      .500000  1.0000 !   5 OK
    .336667     .001000    3.000000 'Trawl:SmlSlope  '   2     1  0      .900000  1.0000 !   6 OK
    .621954     .001000    1.000000 'Trawl:femfinal  '   2     1  0     1.000000  1.0000 !   7 OK
    .408603     .001000    1.000000 'Trawl:feminflct '   2     1  0      .500000  1.0000 !   8 OK
   1.347485     .001000    5.000000 'Trawl:femSlope  '   0     1  0      .900000  1.0000 !   9 NO PICK
  H&L       TYPE:  2
 7 SELECTIVITY PATTERN
  0   0   0   4   0   0    0  AGE TYPES USED
    1.00000         .10 ' H&Lso CATCH BIOMASS'  ! # =  3 VALUE:        .00000
    1.00000         .30 ' H&Lso SIZE COMPS   '  ! # =  4 VALUE:     -200.89854
 1  1  0  0   0  0  SEL. COMPONENTS
  48.545440   20.000000   70.000000 'H&L:transition  '   2     1  0      .000000   .0000 !  10 OK
    .003079     .000001    1.000000 'H&L:InitSelect  '   2     1  0      .000000   .0000 !  11 OK
    .845426     .001000    1.000000 'H&L:SmlInflect  '   2     1  0      .500000  1.0000 !  12 OK
    .329045     .001000    3.000000 'H&L:SmlSlope    '   2     1  0      .900000  1.0000 !  13 OK
    .294257     .001000    1.000000 'H&L:femfinal    '   2     1  0     1.000000  1.0000 !  14 OK
    .392489     .001000    1.000000 'H&L:feminflct   '   2     1  0      .500000  1.0000 !  15 OK
    .287200     .001000    5.000000 'H&L:femSlope    '   2     1  0      .900000  1.0000 !  16 OK
 SETNET     TYPE:  3
 7 SELECTIVITY PATTERN
  0   0   0   6   0   0    0  AGE TYPES USED
    1.00000         .10 'SetNetCATCHBIOM     '  ! # =  5 VALUE:        .00000
    1.00000         .30 'SetNetSizeComps     '  ! # =  6 VALUE:     -258.68020
 1  1  0  0   0  0  SEL. COMPONENTS
  49.630655   20.000000   60.000000 'StNso:transition'   2     1  0      .000000   .0000 !  17 OK
    .004136     .000001    1.000000 'StNso:InitSelect'   2     1  0      .000000   .0000 !  18 OK
    .781197     .001000     .990000 'StNso:YngInflect'   2     1  0      .500000  1.0000 !  19 OK
    .656844     .001000    3.000000 'StNso:YngSlope  '   2     1  0      .900000  1.0000 !  20 OK
    .149361     .001000    1.000000 'StNso:femfinal  '   2     1  0      .000000   .0000 !  21 OK
    .113405     .001000    1.000000 'StNso:feminflct '   2     1  0      .500000  1.0000 !  22 OK
    .241775     .001000    5.000000 'StNso:femSlope  '   2     1  0      .900000  1.0000 !  23 OK
 RECLso     TYPE:  4
 7 SELECTIVITY PATTERN
  0   0   0   8   0   0    0  AGE TYPES USED
    1.00000         .10 'RECLsoCATCHBIOM     '  ! # =  7 VALUE:        .00000
    1.00000         .30 'RECLsoSIZECOMPS     '  ! # =  8 VALUE:     -252.99725
 1  1  0  0   0  0  SEL. COMPONENTS
  36.117510   15.000000   60.000000 'RCLso:transition'   2     1  0      .000000   .0000 !  24 OK
    .169720     .000001    1.000000 'RCLso:InitSelect'   2     1  0      .000000   .0000 !  25 OK
    .001000     .001000    1.000000 'RCLso:SmlInflect'   2     1  0      .500000  1.0000 !  26 BOUND
    .190624     .001000    5.000000 'RCLso:SmlSlope  '   2     1  0      .900000  1.0000 !  27 OK
    .086473     .001000    1.000000 'RCLso:femfinal  '   2     1  0      .000000   .0000 !  28 OK
    .518722     .001000    1.000000 'RCLso:feminflct '   2     1  0      .500000  1.0000 !  29 OK
    .364425     .001000    5.000000 'RCLso:femSlope  '   2     1  0      .900000  1.0000 !  30 OK
 RECLnor    TYPE:  5
 7 SELECTIVITY PATTERN
  0   0   0  10   0   0    0  AGE TYPES USED
    1.00000         .10 'RECLnorCATCHBIOM    '  ! # =  9 VALUE:        .00000
    1.00000         .30 'RECLnorSIZECOMPS    '  ! # = 10 VALUE:     -256.68697
 1  1  0  0   0  0  SEL. COMPONENTS
  48.607956   15.000000   60.000000 'RCLno:transition'   2     1  0      .000000   .0000 !  31 OK
    .065840     .000001    1.000000 'RCLno:InitSelect'   2     1  0      .000000   .0000 !  32 OK
    .492236     .001000    1.000000 'RCLno:SmlInflect'   2     1  0      .500000  1.0000 !  33 OK
    .127394     .001000    5.000000 'RCLno:SmlSlope  '   2     1  0      .900000  1.0000 !  34 OK
    .315713     .001000    1.000000 'RCLno:femfinal  '   2     1  0      .000000   .0000 !  35 OK
```

```
   .594067      .001000     1.000000 'RCLno:feminflct '   2      1  0      .500000  1.0000 !  36 OK
   .307900      .001000     5.000000 'RCLno:femSlope  '   2      1  0      .900000  1.0000 !  37 OK
  NoRec    TYPE:  6
 2 SELECTIVITY PATTERN
  0   0   0   0   0   0    0  AGE TYPES USED
   .000179  0  1  2 Q, QUANT, LOGERROR=1, BIO=1 or NUM=2
   1.00000        .67 'RecFINnoCPUE          '  ! # = 11 VALUE:        -5.88434
  5.000000     -.200000     1.000000 'NoCalCPU:Seltype'   0    -80  0      .000000    .0000 !  38 NO PICK
 24.000000      .010000    24.000000 'NoCalCPU1:minsiz'   0    -80  0      .000000    .0000 !  39 NO PICK
 76.000000      .001000    76.000000 'NoCalCPU1:maxsiz'   0    -80  0      .000000    .0000 !  40 NO PICK
DFGcpuN    TYPE:  7
 2 SELECTIVITY PATTERN
  0   0   0   0   0   0    0  AGE TYPES USED
   .000784  0  1  2 Q, QUANT, LOGERROR=1, BIO=1 or NUM=2
   1.00000        .37 ' NoCalDFG             '  ! # = 12 VALUE:         8.12522
  5.000000     -.200000     1.000000 'NoCalDFG:Seltyp '   0    -87  0      .000000    .0000 !  41 NO PICK
 24.000000      .010000    24.000000 'NoCalDFG:minsi  '   0    -87  0      .000000    .0000 !  42 NO PICK
 76.000000      .001000    76.000000 'NOCalDFG:maxsi  '   0    -87  0      .000000    .0000 !  43 NO PICK
SoRecFI    TYPE:  8
 2 SELECTIVITY PATTERN
  0   0   0   0   0   0    0  AGE TYPES USED
   .000196  0  1  2 Q, QUANT, LOGERROR=1, BIO=1 or NUM=2
   1.00000        .71 'RecFINsoCPUE          '  ! # = 13 VALUE:        -4.08737
  4.000000     -.200000     1.000000 'SoCalCPU:Seltype'   0    -80  0      .000000    .0000 !  44 NO PICK
 24.000000      .010000    24.000000 'SoCalCPU1:minsiz'   0    -80  0      .000000    .0000 !  45 NO PICK
 76.000000      .001000    76.000000 'SoCalCPU1:maxsiz'   0    -80  0      .000000    .0000 !  46 NO PICK
Tw1CPUE    TYPE:  9
 2 SELECTIVITY PATTERN
  0   0   0   0   0   0    0  AGE TYPES USED
   .005243  0  1  1 Q, QUANT, LOGERROR=1, BIO=1 or NUM=2
   1.00000        .32 'TrawlCPUE             '  ! # = 14 VALUE:         9.81438
  1.000000     -.200000     1.000000 'TrawlSeltype    '   0    -82  0      .000000    .0000 !  47 NO PICK
 20.000000      .010000    20.000000 'TrawlCPUE:minsiz'   0    -82  0      .000000    .0000 !  48 NO PICK
 84.000000      .001000    84.000000 'TrawlCPUE:maxsiz'   0    -82  0      .000000    .0000 !  49 NO PICK
TRITRAW    TYPE: 10
 7 SELECTIVITY PATTERN
  0   0   0  16   0   0    0  AGE TYPES USED
   .024110  0  1  1 Q, QUANT, LOGERROR=1, BIO=1 or NUM=2
   1.00000        .81 'TRI SURVEY BIO        '  ! # = 15 VALUE:        -5.80051
   1.00000        .30 'TRI SIZE COMPS        '  ! # = 16 VALUE:       -62.95066
 1  1  0  0   0  0  SEL. COMPONENTS
 34.666503    26.000000    76.000000 'TriSv:transition'   2     89  0      .000000    .0000 !  50 OK
   .372325      .001000     1.000000 'TriSv:InitSelect'   2     89  0      .000000    .0000 !  51 OK
   .001000      .001000     1.000000 'TriSv:YngInflect'   2     89  0      .500000  1.0000 !  52 BOUND
  3.000000      .001000     3.000000 'TriSv:YngSlope  '   2     89  0      .900000  1.0000 !  53 BOUND
   .355689      .001000     1.000000 'TriSv:femfinal  '   2     89  0      .000000    .0000 !  54 OK
   .001000      .001000     1.000000 'TriSv:feminflct '   2     89  0      .500000  1.0000 !  55 BOUND
  5.000000      .001000     5.000000 'TriSv:femSlope  '   2     89  0      .900000  1.0000 !  56 BOUND
CALCOFI    TYPE: 11
 4 SELECTIVITY PATTERN
  0   0   0   0   0   0    0  AGE TYPES USED
   .000250  0  1  1 Q, QUANT, LOGERROR=1, BIO=1 or NUM=2
   1.00000        .68 'CALCOFISPB            '  ! # = 17 VALUE:        -3.41093
PowPlnt    TYPE: 12
 3 SELECTIVITY PATTERN
  0   0   0   0   0   0    0  AGE TYPES USED
   .011569  0  1  2 Q, QUANT, LOGERROR=1, BIO=1 or NUM=2
    .00000       2.10 'PowPltRectIndex       '  ! # = 18 VALUE:       -35.12782
  1.000000      .000000     1.000000 'PowplntAge1Nos  '   0    -73  0      .000000    .0000 !  57 NO PICK
  1.000000      .000000     1.000000 'PowplntAge1Nos  '   0    -73  0      .000000    .0000 !  58 NO PICK
JuvSurv    TYPE: 13
 3 SELECTIVITY PATTERN
  0   0   0   0   0   0    0  AGE TYPES USED
   .000080  0  1  2 Q, QUANT, LOGERROR=1, BIO=1 or NUM=2
    .00000       2.05 'CenCalJuvIndex        '  ! # = 19 VALUE:       -24.81067
  1.000000      .000000     1.000000 'JuvSurvAge1Nos  '   0    -84  0      .000000    .0000 !  59 NO PICK
  1.000000      .000000     1.000000 'JuvSurvAge1Nos  '   0    -84  0      .000000    .0000 !  60 NO PICK
PierCPU    TYPE: 14
 3 SELECTIVITY PATTERN
  0   0   0   0   0   0    0  AGE TYPES USED
   .000284  0  1  2 Q, QUANT, LOGERROR=1, BIO=1 or NUM=2
    .00000       3.29 'PierRectIndex         '  ! # = 20 VALUE:       -32.78282
  1.000000      .000000     1.000000 'PierIndex1Nos   '   0    -81  0      .000000    .0000 !  61 NO PICK
  1.000000      .000000     1.000000 'PierIndex1Nos   '   0    -81  0      .000000    .0000 !  62 NO PICK
 1 AGEERR: 1: MULTINOMIAL,  0: S(LOG(P))=CONSTANT,  -1: S=P*Q/N
500.000 : MAX N FOR MULTINOMIAL
 3 1=%CORRECT, 2=C.V., 3=%AGREE, 4=READ %AGREE @AGE
   .800000      .300000      .950000 'p AGREE. @1      '   0     80  0      .000000    .0000 !  63 NO PICK
   .050000      .000000      .900000 'p agree @21      '   0     80  0      .000000    .0000 !  64 NO PICK
  1.000000      .001000     2.000000 'POWER            '   0     80  0      .000000    .0000 !  65 NO PICK
   .150000      .010000      .300000 'OLD DISCOUNT     '   0     80  0      .000000    .0000 !  66 NO PICK
   .000001      .001000      .100000 '%MIS-SEXED       '   0     80  0      .000000    .0000 !  67 NO PICK
 0 END OF EFFORT
 0 FIX n FMORTs
 0  MATURITY
 1  GROWTH: 1=CONSTANT, 2=MORT. INFLUENCE
 1.5000 99.0000  AGE AT WHICH L1 AND L2 OCCUR
 1 1=NORMAL, 2=LOGNORMAL
 27.000000   20.000000   60.000000 'FEMALE L1         '   0      1  0      .000000    .0000 !  68 NO PICK
```

```
  75.892728   60.000000   90.000000 'FEMALE LINF      '   0       1  0      .000000     .0000 !  69 NO PICK
    .184333     .050000     .400000 'FEMALE K         '   2       1  0      .000000     .0000 !  70 OK
    .107000     .010000     .990000 'FEMALE CV1       '   0       1  0      .000000     .0000 !  71 NO PICK
    .033000     .010000     .990000 'FEMALE CV21      '   0       1  0      .000000     .0000 !  72 NO PICK
-999.000000   20.000000   40.000000 'MALE L1          '   0       1  0      .000000     .0000 !  73 NO PICK
  65.555310   50.000000   80.000000 'MALE LINF        '   0       1  0      .000000     .0000 !  74 NO PICK
    .212546     .100000     .400000 'MALE K           '   2       1  0      .000000     .0000 !  75 OK
-999.000000     .010000     .990000 'MALE CV1         '   0       1  0      .000000     .0000 !  76 NO PICK
-999.000000     .010000     .990000 'MALE CV21        '   0       1  0      .000000     .0000 !  77 NO PICK
         0  DEFINE MARKET CATEGORIES
 0 ENVIRONMENTAL FXN:     [-INDEX]  [FXN TYPE(1-4)]   [ENVVAR USED]
 0 ESTIMATE N ENVIRON VALUES
21 PENALTIES
    .00000        .30 ' Parm Penalty        '  ! # = 21 VALUE:      -138.29553
-1  1.0  1.0
 0 ENVIRONMENT EFFECT ON EXP(RECR)
22  STOCK-RECR
 3 1=B-H, 2=RICKER, 3=new B-H, 4=HOCKEY
 0 disabled option
    .10000      -1.00 'SPAWN RECR.         '  ! # = 22 VALUE:      -44.06779
    .00001      -.30 'S-R means            '  ! # = 23 VALUE:     -500.90103
   4.710632     .001000   10.000000 'VIR. RECR. MULT.'   2       1  0      .000000     .0000 !  78 BAD DX2
    .198895     .100000     .990000 'B-H S/R PAR.     '   2       1  0      .000000     .0000 !  79 OK
    .070451     .001000   10.000000 'BACK RECR.       '   0       1  0      .000000     .0000 !  80 NO PICK
   1.000000     .010000    2.000000 'S/R STD.         '   0       1  0      .000000     .0000 !  81 NO PICK
    .000000    -.100000     .100000 'RECR. TREND      '   0       1  0      .000000     .0000 !  82 NO PICK
   1.000000     .000000    2.000000 'RECR. MULT.      '   0       1  0      .000000     .0000 !  83 NO PICK
-2 INIT AGE COMP
-999.000000     .001000   30.000000 'Recruit 51       '  -2      51  0      .000000     .0000 !  84 NO PICK
-999.000000     .001000   30.000000 'Recruit 52       '  -2      52  0      .000000     .0000 !  85 NO PICK
-999.000000     .001000   30.000000 'Recruit 53       '  -2      53  0      .000000     .0000 !  86 NO PICK
-999.000000     .001000   30.000000 'Recruit 54       '  -2      54  0      .000000     .0000 !  87 NO PICK
-999.000000     .001000   30.000000 'Recruit 55       '  -2      55  0      .000000     .0000 !  88 NO PICK
-999.000000     .001000   30.000000 'Recruit 56       '  -2      56  0      .000000     .0000 !  89 NO PICK
-999.000000     .001000   30.000000 'Recruit 57       '  -2      57  0      .000000     .0000 !  90 NO PICK
-999.000000     .001000   30.000000 'Recruit 58       '  -2      58  0      .000000     .0000 !  91 NO PICK
-999.000000     .001000   30.000000 'Recruit 59       '  -2      59  0      .000000     .0000 !  92 NO PICK
    .025170     .001000   30.000000 'Recruit 60       '   2      60  0      .000000     .0000 !  93 OK
    .022693     .001000   30.000000 'Recruit 61       '   2      61  0      .000000     .0000 !  94 OK
    .215116     .001000   30.000000 'Recruit 62       '   2      62  0      .000000     .0000 !  95 OK
    .950057     .001000   30.000000 'Recruit 63       '   2      63  0      .000000     .0000 !  96 OK
    .015699     .001000   30.000000 'Recruit 64       '   2      64  0      .000000     .0000 !  97 OK
    .014227     .001000   30.000000 'Recruit 65       '   2      65  0      .000000     .0000 !  98 OK
    .017959     .001000   30.000000 'Recruit 66       '   2      66  0      .000000     .0000 !  99 OK
    .031470     .001000   30.000000 'Recruit 67       '   2      67  0      .000000     .0000 ! 100 OK
    .041186     .001000   30.000000 'Recruit 68       '   2      68  0      .000000     .0000 ! 101 OK
    .048643     .001000   30.000000 'Recruit 69       '   2      69  0      .000000     .0000 ! 102 OK
    .023222     .001000   30.000000 'Recruit 70       '   2      70  0      .000000     .0000 ! 103 OK
    .292197     .001000   30.000000 'Recruit 71       '   2      71  0      .000000     .0000 ! 104 OK
    .042672     .001000   30.000000 'Recruit 72       '   2      72  0      .000000     .0000 ! 105 OK
    .042860     .001000   30.000000 'Recruit 73       '   2      73  0      .000000     .0000 ! 106 OK
    .313309     .001000   30.000000 'Recruit 74       '   2      74  0      .000000     .0000 ! 107 OK
    .110532     .001000   30.000000 'Recruit 75       '   2      75  0      .000000     .0000 ! 108 OK
    .025041     .001000   30.000000 'Recruit 76       '   2      76  0      .000000     .0000 ! 109 OK
    .010148     .001000   30.000000 'Recruit 77       '   2      77  0      .000000     .0000 ! 110 OK
    .459277     .001000   30.000000 'Recruit 78       '   2      78  0      .000000     .0000 ! 111 OK
    .045566     .001000   30.000000 'Recruit 79       '   2      79  0      .000000     .0000 ! 112 OK
    .164267     .001000   30.000000 'RECRUIT 80       '   2      80  0      .000000     .0000 ! 113 OK
    .028458     .001000   30.000000 'RECRUIT 81       '   2      81  0      .000000     .0000 ! 114 OK
    .030986     .001000   30.000000 'RECRUIT 82       '   2      82  0      .000000     .0000 ! 115 OK
    .002985     .001000   30.000000 'RECRUIT 83       '   2      83  0      .000000     .0000 ! 116 OK
    .011935     .001000   30.000000 'RECRUIT 84       '   2      84  0      .000000     .0000 ! 117 OK
    .208723     .001000   30.000000 'RECRUIT 85       '   2      85  0      .000000     .0000 ! 118 OK
    .028990     .001000   30.000000 'RECRUIT 86       '   2      86  0      .000000     .0000 ! 119 OK
    .026662     .001000   30.000000 'RECRUIT 87       '   2      87  0      .000000     .0000 ! 120 OK
    .030584     .001000   30.000000 'RECRUIT 88       '   2      88  0      .000000     .0000 ! 121 OK
    .110022     .001000   30.000000 'RECRUIT 89       '   2      89  0      .000000     .0000 ! 122 OK
    .003577     .001000   30.000000 'RECRUIT 90       '   2      90  0      .000000     .0000 ! 123 OK
    .035985     .001000   30.000000 'RECRUIT 91       '   2      91  0      .000000     .0000 ! 124 OK
    .029094     .001000   30.000000 'RECRUIT 92       '   2      92  0      .000000     .0000 ! 125 OK
    .007594     .001000   30.000000 'RECRUIT 93       '   2      93  0      .000000     .0000 ! 126 OK
    .016086     .001000   30.000000 'RECRUIT 94       '   2      94  0      .000000     .0000 ! 127 OK
    .014554     .001000   30.000000 'RECRUIT 95       '   2      95  0      .000000     .0000 ! 128 OK
    .008169     .001000   30.000000 'RECRUIT 96       '   2      96  0      .000000     .0000 ! 129 OK
    .018026     .001000   30.000000 'RECRUIT 97       '   2      97  0      .000000     .0000 ! 130 OK
    .004312     .001000   30.000000 'RECRUIT 98       '   2      98  0      .000000     .0000 ! 131 OK
    .006834     .001000   30.000000 'RECRUIT 99       '   2      99  0      .000000     .0000 ! 132 OK
    .101418     .001000   30.000000 'RECRUIT 100      '   2     100  0      .000000     .0000 ! 133 OK
    .001000     .001000   30.000000 'RECRUIT 101      '   2     101  0      .000000     .0000 ! 134 BOUND
   -.010349     .001000   30.000000 'RECRUIT 102      '  -2     102  0      .000000     .0000 ! 135 NO PICK
   -.011050     .001000   30.000000 'RECRUIT 103      '  -2     103  0      .000000     .0000 ! 136 NO PICK
```

Appendix 2, cont. Data file used for model STATc.

```
2003BocacciodataforCalifornia
2000    1       trawl   H&L     setnet  recSO   recCEN
50      1       1287    200     0       39      86
51      1       1738    277     0       35      98
52      1       1691    276     0       45      86
53      1       1921    321     0       56      72
54      1       1979    337     0       122     91
55      1       2034    290     0       213     108
56      1       2383    356     0       256     121
57      1       2584    365     0       138     120
58      1       2621    649     0       95      193
59      1       2236    565     0       57      160
60      1       2163    351     0       63      125
61      1       1631    354     0       72      94
62      1       1316    343     0       68      109
63      1       1939    386     0       67      111
64      1       1229    259     0       94      85
65      1       1417    305     0       117     132
66      1       2614    332     0       170     142
67      1       4325    328     0       210     140
68      1       2319    321     0       223     166
69      1       1436    304     0       212     154
70      1       1660    298     0       289     204
71      1       1624    424     0       244     167
72      1       2460    598     0       339     226
73      1       6033    1040    0       401     260
74      1       6968    778     0       459     289
75      1       4212    812     0       450     276
76      1       3969    776     0       417     248
77      1       2172    581     0       377     218
78      1       2785    345     142     350     196
79      1       2963    387     161     445     242
80      1       3643    310     151     1755    178
81      1       3977    441     296     841     230
82      1       4302    748     314     1158    358
83      1       4361    380     551     265     301
84      1       3269    309     398     177     67
85      1       1268    126     852     321     66
86      1       1183    328     945     428     171
87      1       1179    321     1081    90      103
88      1       1252    463     368     107     44
89      1       1146    391     971     179     78
90      1       1124    344     659     233     91
91      1       706     177     442     200     92
92      1       488     464     570     167     92
93      1       559     402     413     109     19
94      1       526     208     270     215     5
95      1       377     70      283     44      3
96      1       288     97      95      67      26
97      1       230     58      36      49      107
98      1       73      45      39      29      23
99      1       45      21      7       71      53
100     1       54      19      2       52      60
101     1       37      23      2       60      49
102     1       99      17      1       76      8
-1      1       1       1       1       1       1       1       1       END     OF      CATCH   DATA

-1      1       1       1       END     OF      EFFORT  DATA
73      1       7       12      697.38  -826.84         Age1rec'tIndex(powerplants)
74      1       7       12      105.92  -107.16         Age1rec'tIndex(powerplants)
75      1       7       12      228.84  -199.85         Age1rec'tIndex(powerplants)
76      1       7       12      266.47  -237.74         Age1rec'tIndex(powerplants)
77      1       7       12      43.85   -43.95  Age1rec'tIndex(powerplants)
78      1       7       12      640.21  -198.21         Age1rec'tIndex(powerplants)
79      1       7       12      116.33  -122    Age1rec'tIndex(powerplants)
80      1       7       12      52.49   -41.53  Age1rec'tIndex(powerplants)
81      1       7       12      31.35   -27.16  Age1rec'tIndex(powerplants)
82      1       7       12      13.48   -14.11  Age1rec'tIndex(powerplants)
83      1       7       12      0.14    -0.29   Age1rec'tIndex(powerplants)
84      1       7       12      0.07    -0.18   Age1rec'tIndex(powerplants)
85      1       7       12      24.75   -22.24  Age1rec'tIndex(powerplants)
86      1       7       12      17.02   -10.4   Age1rec'tIndex(powerplants)
87      1       7       12      6.38    -6.33   Age1rec'tIndex(powerplants)
88      1       7       12      28.11   -41.1   Age1rec'tIndex(powerplants)
```

89	1	7	12	485.79	-381.52	Age1rec'tIndex(powerplants)
90	1	7	12	9.12	-12.3	Age1rec'tIndex(powerplants)
91	1	7	12	7.56	-5.54	Age1rec'tIndex(powerplants)
92	1	7	12	37.78	-31.77	Age1rec'tIndex(powerplants)
93	1	7	12	5.64	-6.66	Age1rec'tIndex(powerplants)
94	1	7	12	0.5	-1.01	Age1rec'tIndex(powerplants)
95	1	7	12	0.23	-0.47	Age1rec'tIndex(powerplants)
96	1	7	12	8.24	-10.68	Age1rec'tIndex(powerplants)
97	1	7	12	1.69	-2.48	Age1rec'tIndex(powerplants)
98	1	7	12	2.64	-4.51	Age1rec'tIndex(powerplants)
99	1	7	12	0.07	-0.18	Age1rec'tIndex(powerplants)
100	1	7	12	81.81	-111.54	Age1rec'tIndex(powerplants)
101	1	7	12	14.66	-12.72	Age1rec'tIndex(powerplants)
80	1	7	6	0.917	-0.459	MRFnorth
81	1	7	6	1.28	-0.64	MRFnorth
82	1	7	6	1.326	-0.663	MRFnorth
83	1	7	6	1.377	-0.689	MRFnorth
84	1	7	6	0.388	-0.194	MRFnorth
85	1	7	6	0.75	-0.375	MRFnorth
86	1	7	6	1.39	-0.695	MRFnorth
87	1	7	6	0.914	-0.457	MRFnorth
88	1	7	6	0.294	-0.147	MRFnorth
89	1	7	6	0.457	-0.228	MRFnorth
90	1	7	6	-9	-9	Placeholder
91	1	7	6	-9	-9	Placeholder
92	1	7	6	-9	-9	Placeholder
93	1	7	6	0.202	-0.101	MRFnorth
94	1	7	6	0.351	-0.175	MRFnorth
95	1	7	6	0.482	-0.241	MRFnorth
96	1	7	6	0.535	-0.268	MRFnorth
97	1	7	6	0.42	-0.21	MRFnorth
98	1	7	6	0.432	-0.216	MRFnorth
99	1	7	6	0.802	-0.401	MRFnorth
100	1	7	6	1.961	-0.98	MRFnorth
101	1	7	6	2.022	-1.011	MRFnorth
102	1	7	6	2.618	-1.309	MRFnorth
80	1	7	8	3.401	-1.701	MRFsoCAL
81	1	7	8	3.447	-1.724	MRFsoCAL
82	1	7	8	3.173	-1.587	MRFsoCAL
83	1	7	8	1.318	-0.659	MRFsoCAL
84	1	7	8	1.034	-0.517	MRFsoCAL
85	1	7	8	2.224	-1.112	MRFsoCAL
86	1	7	8	1.91	-0.955	MRFsoCAL
87	1	7	8	0.275	-0.137	MRFsoCAL
88	1	7	8	0.169	-0.085	MRFsoCAL
89	1	7	8	0.997	-0.499	MRFsoCAL
90	1	7	8	-9	-9	Placeholder
91	1	7	8	-9	-9	Placeholder
92	1	7	8	-9	-9	Placeholder
93	1	7	8	1.631	-0.81546	MRFsoCAL
94	1	7	8	1.732	-0.86605	MRFsoCAL
95	1	7	8	0.448	-0.22416	MRFsoCAL
96	1	7	8	0.246	-0.12295	MRFsoCAL
97	1	7	8	0.395	-0.19748	MRFsoCAL
98	1	7	8	0.234	-0.1171	MRFsoCAL
99	1	7	8	0.566	-0.28304	MRFsoCAL
100	1	7	8	1.098	-0.54899	MRFsoCAL
101	1	7	8	1.28	-0.63993	MRFsoCAL
102	1	7	8	2.01	-1.00489	MRFsoCAL
51	1	1	11	0.79	-0.395	CalCOFIindex
52	1	1	11	1.15	-0.575	CalCOFIindex
53	1	1	11	0.797	-0.3985	CalCOFIindex
54	1	1	11	1.388	-0.694	CalCOFIindex
55	1	1	11	1.179	-0.5895	CalCOFIindex
56	1	1	11	0.656	-0.328	CalCOFIindex
57	1	1	11	1.497	-0.7485	CalCOFIindex
58	1	1	11	1.104	-0.552	CalCOFIindex
59	1	1	11	0.318	-0.159	CalCOFIindex
60	1	1	11	0.474	-0.237	CalCOFIindex
61	1	1	11	0.446	-0.223	CalCOFIindex
62	1	1	11	0.341	-0.1705	CalCOFIindex
63	1	1	11	0.686	-0.343	CalCOFIindex
64	1	1	11	0.401	-0.2005	CalCOFIindex
65	1	1	11	0.673	-0.3365	CalCOFIindex
66	1	1	11	1.395	-0.6975	CalCOFIindex
67	1	1	11	-9	-9	Placeholder
68	1	1	11	2.486	-1.243	CalCOFIindex

69	1	1	11	2.585	-1.2925	CalCOFIindex
70	1	1	11	-9	-9	Placeholder
71	1	1	11	-9	-9	Placeholder
72	1	1	11	1.752	-0.876	CalCOFIindex
73	1	1	11	-9	-9	Placeholder
74	1	1	11	-9	-9	Placeholder
75	1	1	11	1.111	-0.5555	CalCOFIindex
76	1	1	11	1.436	-0.718	CalCOFIindex
77	1	1	11	-9	-9	Placeholder
78	1	1	11	0.857	-0.4285	CalCOFIindex
79	1	1	11	-9	-9	Placeholder
80	1	1	11	-9	-9	Placeholder
81	1	1	11	0.68	-0.34	CalCOFIindex
82	1	1	11	-9	-9	Placeholder
83	1	1	11	-9	-9	Placeholder
84	1	1	11	0.48	-0.24	CalCOFIindex
85	1	1	11	0.088	-0.044	CalCOFIindex
86	1	1	11	0.139	-0.0695	CalCOFIindex
87	1	1	11	0.728	-0.364	CalCOFIindex
88	1	1	11	0.633	-0.3165	CalCOFIindex
89	1	1	11	0.486	-0.243	CalCOFIindex
90	1	1	11	0.379	-0.1895	CalCOFIindex
91	1	1	11	0.483	-0.2415	CalCOFIindex
92	1	1	11	0.624	-0.312	CalCOFIindex
93	1	1	11	0.079	-0.0395	CalCOFIindex
94	1	1	11	0.172	-0.086	CalCOFIindex
95	1	1	11	0.065	-0.0325	CalCOFIindex
96	1	1	11	1.144	-0.572	CalCOFIindex
97	1	1	11	0.235	-0.1175	CalCOFIindex
98	1	1	11	0.083	-0.0415	CalCOFIindex
99	1	1	11	0.136	-0.068	CalCOFIindex
100	1	1	11	0.123	-0.0615	CalCOFIindex
101	1	1	11	0.068	-0.034	CalCOFIindex
102	1	1	11	0.31	-0.155	CalCOFIindex
103	1	1	11	0.534	-0.267	CalCOFIindex
77	1	7	10	365.7	-182.85	1977 TRIENNIAL
78	1	7	10	-9	-9	Placeholder
79	1	7	10	-9	-9	Placeholder
80	1	7	10	386.2	-193.1	1980 TRIENNIAL
81	1	7	10	-9	-9	Placeholder
82	1	7	10	-9	-9	Placeholder INDEX
83	1	7	10	503.5	-251.75	1983 TRIENNIAL
84	1	7	10	-9	-9	Placeholder
85	1	7	10	-9	-9	Placeholder INDEX
86	1	7	10	264.4	-132.2	1986 TRIENNIAL
87	1	7	10	-9	-9	Placeholder
88	1	7	10	-9	-9	Placeholder INDEX
89	1	7	10	303.2	-151.6	1989 TRIENNIAL
90	1	7	10	-9	-9	Placeholder
91	1	7	10	-9	-9	Placeholder INDEX
92	1	7	10	75	-37.5	1992 TRIENNIAL
93	1	7	10	-9	-9	Placeholder
94	1	7	10	-9	-9	Placeholder INDEX
95	1	7	10	31	-15.5	1995 TRIENNIAL
96	1	7	10	-9	-9	Placeholder
97	1	7	10	-9	-9	Placeholder INDEX
98	1	7	10	7	-3.5	1998 TRIENNIAL
99	1	7	10	-9	-9	Placeholder
100	1	7	10	-9	-9	Placeholder INDEX
101	1	7	10	12.4	-6.2	2001 TRIENNIAL
84	1	7	13	0.004	-0.002	JuvSurveyrectmt
85	1	7	13	17.384	-8.692	JuvSurveyrectmt
86	1	7	13	0.004	-0.002	JuvSurveyrectmt
87	1	7	13	0.695	-0.3475	JuvSurveyrectmt
88	1	7	13	0.994	-0.497	JuvSurveyrectmt
89	1	7	13	1.095	-0.5475	JuvSurveyrectmt
90	1	7	13	0.182	-0.091	JuvSurveyrectmt
91	1	7	13	0.091	-0.0455	JuvSurveyrectmt
92	1	7	13	0.515	-0.2575	JuvSurveyrectmt
93	1	7	13	0.002	-0.001	JuvSurveyrectmt
94	1	7	13	0.129	-0.0645	JuvSurveyrectmt
95	1	7	13	0.007	-0.0035	JuvSurveyrectmt
96	1	7	13	0.013	-0.0065	JuvSurveyrectmt
97	1	7	13	0.004	-0.002	JuvSurveyrectmt
98	1	7	13	0.018	-0.009	JuvSurveyrectmt
99	1	7	13	0.004	-0.002	JuvSurveyrectmt
100	1	7	13	0.027	-0.0135	JuvSurveyrectmt

```
101  1   7   13  0.051   -0.0255   JuvSurveyrectmt
102  1   7   13  0.079   -0.0395   JuvSurveyrectmt
103  1   7   13  0.342   -0.171  JuvSurveyrectmt
82   1   7   9   166.4   -83.2   areaweightedCPUEfromRalston
83   1   7   9   73.1    -36.55  areaweightedCPUEfromRalston
84   1   7   9   72.3    -36.15  areaweightedCPUEfromRalston
85   1   7   9   30.7    -15.35  areaweightedCPUEfromRalston
86   1   7   9   31.2    -15.6   areaweightedCPUEfromRalston
87   1   7   9   44.4    -22.2   areaweightedCPUEfromRalston
88   1   7   9   51.6    -25.8   areaweightedCPUEfromRalston
89   1   7   9   35.8    -17.9   areaweightedCPUEfromRalston
90   1   7   9   37.1    -18.55  areaweightedCPUEfromRalston
91   1   7   9   26.9    -13.45  areaweightedCPUEfromRalston
92   1   7   9   20.4    -10.2   areaweightedCPUEfromRalston
93   1   7   9   19.7    -9.85   areaweightedCPUEfromRalston
94   1   7   9   23.9    -11.95  areaweightedCPUEfromRalston
95   1   7   9   15.2    -7.6    areaweightedCPUEfromRalston
96   1   7   9   8.7     -4.35   areaweightedCPUEfromRalston
87   1   7   7   3.545   -1.7725   VandenbergCPUE
88   1   7   7   2.349   -1.1745   VandenbergCPUE
89   1   7   7   3.001   -1.5005   VandenbergCPUE
90   1   7   7   6.009   -3.0045   VandenbergCPUE
91   1   7   7   4.637   -2.3185   VandenbergCPUE
92   1   7   7   3.543   -1.7715   VandenbergCPUE
93   1   7   7   2.319   -1.1595   VandenbergCPUE
94   1   7   7   1.46    -0.73   VandenbergCPUE
95   1   7   7   1.721   -0.8605   VandenbergCPUE
96   1   7   7   1.457   -0.7285   VandenbergCPUE
97   1   7   7   1.823   -0.9115   VandenbergCPUE
98   1   7   7   1.646   -0.823  VandenbergCPUE
81   1   7   14  33.058  -16.529   MRFpierRectmt
82   1   7   14  2.807   -1.4035   MRFpierRectmt
83   1   7   14  0.003   -0.0015   MRFpierRectmt
84   1   7   14  0.005   -0.0025   MRFpierRectmt
85   1   7   14  43.127  -21.5635  MRFpierRectmt
86   1   7   14  6.987   -3.4935   MRFpierRectmt
87   1   7   14  0.498   -0.249  MRFpierRectmt
88   1   7   14  13.529  -6.7645   MRFpierRectmt
89   1   7   14  77.056  -38.528   MRFpierRectmt
90   1   7   14  1.081   -0.5405   MRFpierRectmt
91   1   7   14  -9      -9      Placeholder
92   1   7   14  -9      -9      Placeholder
93   1   7   14  -9      -9      Placeholder
94   1   7   14  18.623  -9.3115   MRFpierRectmt
95   1   7   14  0.003   -0.0015   MRFpierRectmt
96   1   7   14  0.312   -0.156  MRFpierRectmt
97   1   7   14  0.13    -0.065  MRFpierRectmt
98   1   7   14  0.003   -0.0015   MRFpierRectmt
99   1   7   14  0.003   -0.0015   MRFpierRectmt
100  1   7   14  0.105   -0.0525   MRFpierRectmt
101  1   7   14  0.003   -0.0015   MRFpierRectmt
102  1   7   14  0.003   -0.0015   MRFpierRectmt
103  1   7   14  0.003   -0.0015   MRFpierRectmt
-1   1   1   1   1       1       END   OF
-1   -1  <== No  aging   error(not     used)
-1   -1
-1   -1
25   25  <==25lengthbins24..68at2cm,72,76 bins
24   26  28  30  32  34  36  38  40  42  44  46  48
     50  52  54  56  58  60  62  64  66  68  72  76
     80
47.6  -0.2876      length@50%maturesslopeEcheverria1987
6.17E-06     3.1712  Length-weightparsfemale1995TriennialTrawl(Ralston)
0.22475      0.03657     eggs/kginterceptandslopeReinterpretedfromPhillipsbyRalston1996
6.17E-06     3.1712  Length-weightparsmale1995TriennialTrawl(Ralston)
[remainder deleted - length compositions]
```